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SVIC NOTES

RESOURCE LETTERS -- ONE SOLUTION TO AN INFORMATION PROBLEM

In this short note I would like to suggest that the use of resource letters may be valuable to investigators in the various fields of shock and vibration.

A resource letter does not serve the same function as a literature review or a feature article; it gives the reader current awareness on a subject or a statement of the current state-of-the-art in a particular subject. A resource letter is designed for quick entry into the full range of basic resources available on a particular subject, not just journal articles. It could be used by someone preparing training material or material for a short course. Also, a resource letter could be used by individuals who are new to an organization or subject area, and therefore need to be brought up to speed quickly.

I will confess that my ideas on resource letters are based on the excellent series of such letters published in The American Journal of Physics. Three good examples of letters from The American Journal of Physics are the ones on Biomedical Engineering[1], Mechanical Properties of Fluids[2], and Environmental Noise Control[3].

A resource letter should contain an introductory section which, for example, might contain background information, recent major developments or a brief technical exposition on a specific subject area. A list should be provided of the most useful journals, the most useful conferences and conference proceedings and an annotated bibliography of the basic reference books. The rest of the resource letter should contain references to the literature organized under several sub-headings. How much annotation an author does on each article is a personal choice, but some running commentary is essential.

I am sure there are many subject areas in shock and vibration where resource letters would be most useful. Consider, for example, modal analysis, underwater shock, damping and transportation environments. SVIC would appreciate your sending any suggestions you may have for topics and authors for this potential new Digest entry. If you agree that it should be done, it will be done.

J.G.S.

[1] *Shonle, J.I., "Resource Letter BE-1 on Biomedical Engineering," Amer. J. Physics, 39, pp 1423-1432 (Dec 1971).*
[2] *Stanley, R.C., "Resource Letter MPF-1: Mechanical Properties of Fluids," Amer. J. Physics, 42, pp 440-451 (June 1974).*
[3] *Rossing, T.D., "Resource Letter ENC-1: Environmental Noise Control," Amer. J. Physics, 46 (5) (May 1978).*

EDITORS RATTLE SPACE

WILL CRITICAL PAPER REVIEWS BECOME OBSOLETE?

Each time I serve as an organizer of a session for a meeting of a technical society, I find the process of paper review more difficult to implement. It appears that fewer people have the time to review or the interest in reviewing technical papers. This trend is disturbing in view of the fact that the number of papers published increases every year. I suspect, however, that many of the papers published are not critically reviewed and that therein lies one cause of the literature explosion.

It is advantageous to the technical community to have critical reviews of technical papers. Often the quality of a paper is improved by a reviewer's suggestions. In addition, the review process serves to validate technical work, minimize duplication, avoid commercialism, and concentrate the literature of a subject. The last means that users of the literature spend less time searching for pertinent work. Thus critical literature reviews do have distinct advantages in the technical paper publishing process. Why then do few periodicals use the process effectively? I can cite a few possible reasons: lack of recognition for the reviewer, decreased work time available for technical personnel for purposes of review, pressure to increase the number of papers published, and pressure to publish papers faster.

Because the review efforts of an individual are usually not recognized, he will most likely spend his available time researching and writing new papers. This is a self-defeating cycle in the publishing process that serves either to decrease the number of published papers or to a general deterioration of the quality of the literature. How are reviewers now recognized? Some journals periodically publish the names of reviewers, but apparently this is not enough recognition. Perhaps the names of reviewers should be appended to the paper or perhaps the reviewer should be paid an honorarium. Such payment would have to be absorbed in the publishing costs, however, and would probably restrict publication of marginal material. Perhaps there should be a rule requiring three reviews for each paper published.

It is my opinion that some action should be taken on this problem. New ideas are needed to rescue a good and worthwhile process that is in danger of extinction.

R.L.E.

TURBOMACHINE BLADE VIBRATION

J.S. Rao*

Abstract. ***This article reviews the literature that has appeared since 1979 on free vibrations and excitation forces of blades and blade response.***

This article is part of a series of reviews [60-62] on turbomachinery blade vibrations. Other reviews on similar topics have appeared in the last three years [39, 41, 42].

FREE VIBRATIONS

Jadvani [28] used Lagrange's equations in a free vibration analysis of rotating pre-twisted blades of asymmetric aerofoil cross section that were mounted on a disk at a stagger angle; he provided several design charts for determining the coupled natural frequencies. A dedicated discretization technique for twisted beams with asymmetric cross section has been published [9], as has an approach based on the Nemat-Nasser variational statement for estimating natural frequencies of tapered blades [40]. The Reissner variational method was used for a Timoshenko beam [69] and then extended to account for pre-twist [81], asymmetry [82], rotation [83], and general blades [37]. Simple finite elements have been developed for thick pre-twisted blades to account for shear and rotary inertia [1]. The effects of thermal stresses and gas bending loads have been accounted for [7].

Natural frequencies of shallow rectangular shells have been determined with the help of the classical Ritz method [44]. The effects of rotation [43] and disk radius and stagger angle [45] were included. A finite difference energy method that utilizes a simple rectangular grid mapped to a blade surface and parameter functions is available [30]. An extended transfer matrix-finite element method has been published [72] as have curved cylindrical shell finite elements for a blade with a weighted edge [19]. Triangular shell elements have been used [79] for rotating pre-twisted cantilever plates. Substructure techniques and wave propagation in periodic systems have been used in conjunction with the finite element method for impeller type blades [17]. Several practical applications of turbine blading have been considered [18].

Vibration amplitudes and stresses in gas turbine compressor blades have been determined using the finite element method and the holography interference technique [13]. Blade structural dynamic analysis has been done [8]. Hamilton's principle and geometric nonlinearity have been used to derive general aeroelastic equations of motion for twisted, symmetric, nonuniform wind turbine blades [32]. The finite element method has been used in a nonlinear dynamic analysis of blades of rectangular cross section [50].

Damping values of turbine blades have been determined experimentally [4]. The effect of blade packeting has been considered [3, 86, 88]. A semi-transfer matrix procedure was used [5] to determine natural frequencies of blades experimentally with a damping wire. Experiments have been conducted [87] to investigate the vibration characteristics of an LP runner blade stage using lacing wire. The finite element method has been used to determine the natural frequencies and mode shapes of a shrouded turbine blade system with dry friction [90]. A finite element procedure based on the Rayleigh-Ritz and Galerkin methods was used [53] to study the effect of attachment flexibility on torsional vibrations of pre-twisted tapered rotating blades.

Irretier [21] used a direct integration approach to study coupled vibrations of rotating blades and the disk; the blade-disk Junction was rigid. He later extended the study to account for elastic coupling

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at the junction [24] and rotating bladed disks [22]. He described the support with a flexibility matrix and obtained the solution from transfer matrices [23] and direct numerical integration [25]. Irretier and Schmidt [26] used a receptance technique for eigen frequencies and mode shapes of mistuned blades and response due to excitation by component mode synthesis.

A new cyclic symmetry method for bladed disk assemblies has been developed; theoretical vlaues were compared with experimental results [48]. A finite element blade-disk segment model [38] composed of a sector element for disk and airfoil element [85] have been used.

Studies on blaaded disk vibration have taken into account the effects of packeting [11]. An analytical study for disk blade shroud assemblies based on system mode analysis has been given [78]. Heated blades have been considered in a finite element analysis for a shrouded bladed disk rotor stage [6]. Holographic measurements of a detuned bladed disk have been conducted [80]. The effect of lacing wire on the natural frequencies of rotating bladed disks was considered [89] using a new dynamic substructuring method. A parametric study of a bladed disk system with Coulomb and structural damping accounted for mistuning and excitation [51]. The nonlinear response of several mistuned blades connected to a rigid disk has been considered [52]; dry friction was taken into account.

BLADE EXCITATION FORCES

The unsteady lift of an isolated cambered blade in a transverse convecting gust with an angle of attack has been determined [27], as have the unsteady forces due to a sinusoidal gust on a rotor cascade [55]. The effect of normal shock in the blade passage was studied using semiactuator disk theory [49]. Blade forces and moments due to the interaction of adjacent cascades have been determined [46]; incompressible plane unsteady potential flow theories were used in conjunction with time marching techniques. Kemp and Sears and Osborne analyses have been used to determine unsteady forces and moments of a two-dimensional thin air foil stage [59]; camber angle of attack, Mach number, and both transverse and chordwise gusts were considered.

Unsteady forces acting on vibrating blades in a cascade have been studied [16]. Experimental investigations have been conducted on a large low-speed simple stage research compressor to determine pressure lfit data [12]; results were compared with a compressible flat plate cascade analysis. Wind tunnel tests have been done in which stationary and rotating nozzles were inverted [58]. Miniature dynamic pressure transducers embedded in test blades were used for pressure measurements; an analog computer was used to determine the forces due to partial admission. A dynamic cascade facility has been described for flutter and aerodynamic damping investigations [34]. Periodic aerodynamic force coefficients for axial, torsional, and tangential modes have been determined by interferometric measurements [35, 36] and the results compared with those from the time marching control volume method [57]. A research facility on turbine rotor-stator aerodynamic interaction has been described [10].

A modified hydraulic analogy using two-dimensional incompressible free surface water flow has been proposed to simulate two-dimensional compressible isentropic flow of gases with any specific heat ratio [63, 64]. The analogy was analytically established with studies on converging-diverging nozzles. Errors in the analogy were studied for non-isentropic flows with normal and oblique shocks [65, 66], and nozzle exit flows were studied by hydraulic analogy [67]. This analogy was experimentally studied on a flat water table [70] to establish its validity for modeling real gas flows. A flat plate stage in compressible flow was modeled on a rotating water table to experimentally determine the non-steady forces [59]; the results were compared with theoretical values.

BLADE RESPONSE

The response to slip damping at circular root geometry has been determined both analytically and experimentally [33]. Available unsteady force coefficients have been used [47] to determine bending response of blades; the results were compared with experimental values. A simple analysis has been presented for the response of a blade with slip at the root [31]; the results were compared with experimental observations. The effects of slipping force and stiffness of a damper on the reso-

nant response have been investigated both analytically and experimentally [15]. Friction and material damping have been considered and Coulomb damping optimized for resonant operating conditions [14].

An energy balance between unsteady aerodynamic work and energy dissipated due to aerodynamic damping was used to predict blade resonant vibrations [20]. The forced response was determined by using experimental unsteady aerodynamic gust data for flat and cambered cascade airfoils. Aerodynamic interaction of a stage has been studied to determine the dynamic response [84], and experimental investigations have been done in an air turbine to determine blade vibration amplitudes [2]. Lagrange's equations and modal analysis have been used to determine the forced vibrations of rotating pre-twisted blades [29]. A test turbine has been used to determine resonant stresses due to nozzle passing and impulse excitation [54]; measured and calculated results agreed well. An experimental test rig with nozzles simulated by permanent magnets has been used [68] to test pre-twisted blades; analytical and experimental results were in good agreement. A general forced vibration program based on Lagrange's equations and modal analysis has been used to assess nozzle passing frequency for twisted asymmetric tapered rotating blades [28].

Unsteady lift coefficients based on the Kemp and Sears model have been used to determine self-excited vibration of turbomachinery blades [71]. The effects of gyroscopic forces on the dynamic behavior of rotating blades have been considered [73]; Coriolis forces were included in the analysis [74]. Instabilities due to harmonic variation with time of the precessional rate from whirling and other causes have been given [75]. The finite element method based on Hamilton's principle has been used to study the dynamic stability of rotor blades; quasi-steady two-dimensional airfoil theory was used [76].

Statistical procedures have been used to estimate the fatigue life of mistuned rotor blades [77]. A stationary Gaussian white noise process was assumed for excitation. A vibration design method for pinned root control stage blades has been described [56].

REFERENCES

1. Abbas, B.A.H., "Simple Finite Elements for Dynamic Analysis of Thick Pre-Twisted Blades," Aeronaut. J., 83 (827), p 450 (1979).

2. Beckmann, J. and Wachter, J., "Measurement of the Influence of Flow Distortions on the Blade Vibration Amplitude in an Air Turbine," ASME Paper 81-DET-135.

3. Bernante, R., Macchi, A., and Magneschi, P., "Effect of Packeting on Turbine Blades Vibrations," Proc. IFToMM Intl. Conf. Rotordynamic Problems in Power Plants, Rome, p 247 (Sept 28-Oct 1, 1982).

4. Brown, W.G., "Determination of Damping Values for Turbine Blades," ASME Paper 81-DET-131.

5. Butkovic, M., "Vibrations of Blades with Damping Wire," Proc. IFToMM Intl. Conf. Rotordynamic Problems in Power Plants, Rome, p 237 (Sept 28 - Oct 1, 1982).

6. Chen, L.T. and Dugundji, J., "Investigation of the Vibration Characteristics of Shrouded Bladed Disk Rotor Stages," J. Aircraft, 17 (7), pp 479 (1980).

7. Chen, L.T. and Dugundji, J., "Thermal Stress and Gas Bending Effects on Vibration of Compressor Rotor Stages," J. Aircraft, 17 (8), p 576 (1980).

8. Dickerson, E.O., "Turbine Blade Structural Dynamic Analysis," 21st Struc., Struc. Dynam. Matls. Conf., Seattle, WA, p 998 (May 1980).

9. Downs, B., "Vibration Analysis of Turbomachinery Blades Using Dedicated Discretization and Twisted Beam Theory," ASME Paper 79-DET-85.

10. Dring, R.P., Joslyn, H.D., Hardin, L.W., and Wagner, J.H., "Research on Turbine Rotor-Stator Aerodynamic Interaction and Rotor Negative Incidence Stall," United Tech. Res. Ctr., East Hartford, CT, Rept. No. R81-915048, AFWAL-TR-81-2114 (1981).

11. Ewins, D.J., "Further Studies of Bladed Disk Vibration: Effects of Packeting," Conf. Vibrations Rotating Mach., Instn. Mech. Engr., Univ. Cambridge, UK, p 97 (Sept 1980).

12. Fleeter, S., Bennett, W.A., and Jay, R.L., "The Time-Variant Aerodynamic Response of a Stator Row Including the Effects of Airfoil Camber," J. Engrg. Power, Trans. ASME, 102, p 334 (1980).

13. Fu, Z.F., "Determination of Vibration Amplitudes and Stresses Using the Holography Interference Techniques and Finite Element Method," ASME Paper 81-DET-132.

14. Fu-Sheng, C., Wassel, M., and Mosimann, J., "Combined Friction and Material Damping of Resonant Steam Turbine Blade Response," ASME Paper 81-DET-136.

15. Griffin, J.H., "Friction Damping of Resonant Stresses in Gas Turbine Engine Airfoils," J. Engrg. Power, Trans. ASME, 102, p 329 (1980).

16. Hanamura, Y., Tanaka, H., and Yamaguchi, K., "A Simplified Method to Measure Unsteady Forces Acting on the Vibrating Blades in Cascade," Bull. JSME, 23 (180), p 880 (1980).

17. Henry, R., "Calcul des Frequences et Modes des Structures Repetitives Circularies," J. de Mecanique Appliquee, 4, p 61 (1980).

18. Henry, R., "Contribution a L'Etude Dynamique des Machines Tournantes," D.Sc. Thesis, INSA, Lyon (1981).

19. Hoa, S.V., "Vibration Frequency of a Curved Blade with Weighted Edge," J. Sound Vib., 79 (1), p 107 (1981).

20. Hoyniak, D. and Fleeter, S., "Prediction of Aerodynamically Induced Vibrations in Turbomachinery Blading," Fluid-Structure Interactions in Turbomachinery, Winter Ann. Mt. ASME, p 1 (Nov 1981).

21. Irretier, H., "Coupled Vibrations of Blades in Bending-Bending-Torsion and Disks in Out-of-Plane and In-Plane Motion," ASME Paper 79-DET-90.

22. Irretier, H., "Eigenschwingungen Retierender, Beschaufelter Scheiben," Schwingungen Von Maschine, Fundament Und Baugrund, VDI Berichte, 381, p 167 (1980).

23. Irretier, H., "Schwingungsanregung und antwort von Turbinenschaufeln unter Berucksichtigung der elastischen Eigenschaften der Trägerscheibe," Schiffstechnik, 27 (4), p 199 (1980).

24. Irretier, H., "Zum Einfluss des Schwingungsverhaltens eines Scheibenförmigen Tragkorpers auf die Eigenfrequenzen der Schaufeln thermischer Turbomaschinen," Ing. Arch., 50, p 85 (1981).

25. Irretier, H. and Mahrenholtz, O., "Eigen Frequencies and Mode Shapes of a Free Standing, Twisted, Tapered and Rotating Blade with Respect to an Elastically Supported Root," ASME Paper 81-DET-125.

26. Irretier, H. and Schmidt, K.J., "Mistuned Bladed Disks -- Dynamical Behaviour and Computation," Proc. IFToMM Intl. Conf. Rotordynamic Problems Power Plants, Rome, p 215 (Sept 28 - Oct 1, 1982).

27. Ishihara, K. and Funakawa, M., "Analysis of an Unsteady Aerodynamic Force on a Blade Due to Uniform Amplitude Gusts," Bull. JSME, 22 (166), p 529 (1979).

28. Jadvani, H.M., "Vibration of Turbine Blades," Ph.D. Thesis submitted to Indian Institute of Technology, Delhi (1982).

29. Jadvani, H.M. and Rao, J.S., "Forced Vibrations of Rotating Pretwisted Blades," Proc. IFToMM Intl. Conf. Rotordynamic Problems Power Plants, Rome, p 259 (Sept 28 - Oct 1, 1982).

30. Jensen, K.R., "A Shell Analysis of Turbine Blade Vibrations," Intl. J. Mech. Sci., 24 (10), p 581 (1982).

31. Jones, D.I.G., "Vibrations of a Compressor Blade with Slip at the Root," AFWAL-TR-80-4003 (1980).

32. Kaza, K.R.V., "Nonlinear Aeroelastic Equations of Motion of Twisted, Nonuniform, Flexible Horizontal-Axis Wind Turbine Blades," DOE/NASA/3139-1.

33. Kimberling, M.C., "Slip Damping of Turbine Blades," AFIT/GAE/AA.78 D-11 (Dec 1978).

34. Kovats, Z., "Dynamic Cascade Facility and Methods for Investigating Flow-Excited Vibration and Aerodynamic Damping of Model Low Pressure Blade Groups," Paper presented at ASME Winter Ann. Mtg., New York (Dec 2-7, 1979).

35. Kovats, Z., "Interferometrically Measured Aerodynamic Forces on a Vibrating Turbine Blade Group," J. Engrg. Power, Trans. ASME, 102, p 638 (1980).

36. Kovats, Z., "Interferometrically Measured Partial Admission Impulse Blade Forces," Aero-Thermodynamics of Steam Turbines, ASME, p 43 (Nov 1981).

37. Kulkarni, S.V., Subrahmanyam, K.B., and Rao, J.S., "Coupled Bending-Bending-Torsion Vibrations of Turbo-Machine Blading Treated by Reissner Method," Proc. 1st Natl. Conf. Mechanisms and Machines, Bombay, India, p R-19 (Dec 2-3, 1981).

38. Kuo, P.S., "On the Formulation of Coupled/Uncoupled Dynamics Analysis of Blade-Disc Assemblies," ASME Paper 81-DET-126.

39. Lalanne, M., "Vibration in Jet Engines," Shock Vib. Dig., 12 (9), p 3 (1980).

40. Lang, K.W. and Nemat-Nasser, S., "An Approach for Estimating Vibration Characteristics of Nonuniform Rotor Blades," AIAA J., 17, p 995 (1979).

41. Leissa, A.W., "Vibrations of Turbine Engine Blades by Shell Analysis," Shock Vib. Dig., 12 (11), p 3 (1980).

42. Leissa, A.W., "Vibrational Aspects of Rotating Turbomachinery Blades," Appl. Mech. Rev., 34, p 629 (1981).

43. Leissa, A.W., Lee, J.K., and Wang, A.J., "Vibrations of Twisted Rotating Blades," ASME Paper 81-DET-127.

44. Leissa, A.W., Lee, J.K., and Wang, A.J., "Vibrations of Cantilevered Shallow Cylindrical Shells of Rectangular Plan Form," J. Sound Vib., 78 (3), p 311 (1981).

45. Leissa, A.W., Lee, J.K., and Wang, A.J., "Rotating Blade Vibration Analysis Using Shells," J. Engrg. Power, Trans. ASME, 104, p 296 (1982).

46. Lienhart, W., "Aerodynamische Erregungskräfte von Schaufelschwingungen in axialen Turbomaschinen infolge der Interferenz benachbarter Schaufelgitter," Ing. Arch., 48, p 239 (1979).

47. Matsuura, T., "Blade Bending Vibration Induced by Wakes," J. Mech. Engrg. Sci., 21 (5), p 361 (1979).

48. Michimura, S., Nagamatsu, A., Ikeuchi, T., and Shirai, M., "Vibration Analysis on Bladed Disk Assemblies of Axial-Flow Turbines," Bull. JSME, 24 (197), p 1988 (1981).

49. Micklow, J. and Jeffers, J., "Semi-Actuator Disk Theory for Compressor Choke Flutter," NASA-CR-3426, FR-12976 (1981).

50. Murty, A.V.K. and Raman, A., "Non-Linear Dynamic Analysis of Rotors by Finite Element Method," J. Sound Vib., 69 (4), p 559 (1980).

51. Muszynska, A. and Jones, D.I.G., "A Parametric Study of Dynamic Response of a Discrete Mode of Turbomachinery Bladed Disk," ASME Paper 81-DET-137.

52. Muszynska, A., Jones, D.I.G., Lagnese, T., and Whitford, L., "On Nonlinear Response of Multiple Blade Systems," Shock Vib. Bull., U.S. Naval Res. Lab., Proc. 51, Pt. 3, p 89 (1981).

53. Nagaraj, V.T. and Sahu, N., "Torsional Vibrations of Non-uniform Rotating Blades with Attachment Flexibility," J. Sound Vib., 80 (3), p 401 (1982).

54. Namura, K., "Tangential Vibration of Integral Turbine-Blades Due to Partial Admission," Fluid Structure Interactions in Turbomachinery, Winter Ann. Mtg. ASME, p 25 (Nov 1981).

55. Nishiyama, T. and Yanome, M., "Unsteady Responses and Wake Energy of Turbine Rotor Cascade to Sinusoidal Gust," Tohoku Univ., Tech. Rept., 45 (2) (1980).

56. Partington, A.J., "Vibration Analysis of Steam Turbine Pinned Root Control Stage Blades," Proc. IFToMM Intl. Conf. Rotordynamic Problems in Power Plants, Rome, p 227 (Sept 28 - Oct 1, 1982).

57. Patch, L., Whirlow, D.K., and Farn, C.L.S., "Unsteady Transonic Flow in Turbine Cascades with Partial Admission," Aero-Thermodynamics of Steam Turbines, ASME, p 47 (Nov 1981).

58. Pigott, R., "Turbine Blade Vibration due to Partial Admission," Intl. J. Mech. Sci., 22, p 247 (1980).

59. Ramana Rao, V.V., "Unsteady Blade Forces in a Turbomachine," Ph.D. Thesis submitted to Indian Institute of Technology, Delhi (1982).

60. Rao, J.S., "Natural Frequencies of Turbine Blading -- A Survey," *Shock Vib. Dig., 5 (10)*, p 1 (1973).

61. Rao, J.S., "Turbine Blading Excitation and Vibration," Shock Vib. Dig., 9 (3), p 15 (1977).

62. Rao, J.S., "Turbomachine Blade Vibration," Shock Vib. Dig., 12 (2), p 19 (1980).

63. Rao, J.S., "Hydraulic Analogy for Compressible Gas Flow in Converging Nozzles," Stress Tech. Inc., Rochester, NY, ID 002-1 (Dec 5, 1980).

64. Rao, J.S., "Simulation of Compressible Gas Flow in Converging-Diverging Nozzles by the Use of Hydraulic Analogy," Stress Tech. Inc., Rochester, NY, ID 002-2 (Jan 1981).

65. Rao, J.S., "An Examination of Errors in Hydraulic Analogy for Nozzle Flows with Compressible Normal Shock," Stress Tech. Inc., Rochester, NY, ID 002-3 (Feg 19, 1981).

66. Rao, J.S., "The Effect of Straight Oblique Shock Waves on Hydraulic Analogy," Stress Tech. Inc., Rochester, NY, ID-002-4 (Feb 19, 1981).

67. Rao, J.S., "A Study of Nozzle Exit Flows by Hydraulic Analogy," Stress Tech. Inc., Rochester, NY, ID-002-5 (Mar 9, 1981).

68. Rao, J.S. and Jadvani, H.M., "Analytical and Experimental Investigation of Rotating Blade Response due to NPF Excitation," paper presented at 53rd Shock and Vibration Symp., Danvers, MA (Oct 26-28, 1982).

69. Rao, J.S., Kulkarni, S.V., and Subrahmanyam, K.B., "Application of the Reissner Method to a Timoshenko Beam," J. Appl. Mech., Trans. ASME, 48, p 672 (1981).

70. Rao, J.S., Ramana Rao, V.V., and Seshadri, V., "Hydraulic Analogy for Non Ideal Compressible Gas Flows," Proc. IFToMM Intl. Conf. Rotordynamic Problems in Power Plants, Rome, p 267 (Sept 28 - Oct 1, 1982).

71. Rao, S.S.P., Mukhopadhyay, V., and Rao, J.S., "Self Excited Vibration of Turbomachine Blades," Proc. 5th Intl. Symp. on Airbreathing Engines, Bangalore, India (Feb 16-21, 1981).

72. Sankar, S. and Hoa, S.V., "An Extended Transfer Matrix-Finite Element Method for Free Vibration of Plates," J. Sound Vib., 70 (2), p 205 (1980).

73. Sisto, F. and Chang, A.T., "The Influence of Gyroscopic Forces on the Dynamic Behaviour of Rotating Blades," Proc. 5th Intl. Symp. on Airbreathing Engines, Bangalore, India (Feb 16-21, 1981).

74. Sisto, F., Chang, A.T., and Sutcu, M., "The Influence of Coriolis Forces on Gyroscopic Motion of Spinning Blades, 27th Intl. Gas Turbine Conf., London (Apr 18-22, 1982).

75. Sisto, F., Chang, A.T., and Sutcu, M., "Blade Excitation due to Gyroscopic Forces," Proc. IFToMM Intl. Conf. Rotordynamic Problems in Power Plants, Rome, p 279 (Sept 28 - Oct 1, 1982).

76. Sivaneri, N.T. and Chopra, I., "Dynamic Stability of a Rotor Blade Using Finite Element Analysis," AIAA J., 20 (5), p 716 (1982).

77. Sogliero, G. and Srinivasan, A.V., "Fatigue Life Estimates of Mistuned Blades Via a Stochastic Approach," AIAA J., 18 (3), p 318 (1980).

78. Spence, P.W., "A Practical Approach to Systems Mode Analysis," ASME Paper 81-DET-130.

79. Sreenivasamurty, S. and Ramamurty, V., "A Parametric Study of Vibration of Rotating Pre-twisted and Tapered Low Aspect Ratio Cantilever Plates," J. Sound Vib., 76 (3), p 311 (1981).

80. Stange, W.A. and McBain, J.C., "An Investigation of Dual Mode Phenomena in a Mistuned Bladed Disk," ASME Paper 81-DET-133.

81. Subrahmanyam, K.B., Kulkarni, S.V., and Rao, J.S., "Coupled Bending-Bending Vibrations of Pre-Twisted Cantilever Blading Allowing for Shear Deflection and Rotary Inertia by the Reissner Method," Intl. J. Mech. Sci., 23 (9), p 517 (1981).

82. Subrahmanyam, K.B., Kulkarni, S.V., and Rao, J.S., "Coupled Bending-Torsion Vibrations of Rotating Blades of Asymmetric Aerofoil Cross-section with Allowance for Shear Deflection and Rotary Inertia by Use of the Reissner Method," J. Sound Vib., 75 (1), p 17 (1981).

83. Subrahmanyam, K.B., Kulkarni, S.V., and Rao, J.S., "Analysis of Lateral Vibrations of Rotating Cantilever Blades Allowing for Shear Deflection and Rotary Inertia by Reissner and Potential Energy Methods," Mechanism and Machine Theory, 17 (4), p 235 (1982).

84. Tadros, R.N. and Botman, M., "Dynamic Response of Blades and Vanes to Wakes in Axial Turbomachinery," ASME Paper 81-DET-33.

85. Thomas, J. and Sabuncu, M., "Vibration Characteristics of Asymmetric Cross-Section Bladed Disk under Rotation," ASME Paper 79-DET-94.

86. Umemura, S., Mase, M., and Kadoya, Y., "Vibration Analysis of Grouped Blades of Turbines by the Finite Element Method," Mitsubishi Heavy Industries Tech. Rev., p 1 (June 1979).

87. Wachter, J., Jarosch, J., and Pfeiffer, R., "Experimental Investigation on the Vibratory Characteristics of an Industrial Steam Turbine LP-Runner Blade with Lacing Wire," ASME Paper 81-DET-134.

88. Wachter, J. and Wolfs, J., "Investigation of Vibration of Shrouded Turbine Blades," ASME Paper 81-DET-129.

89. Wildheim, S.J., "Natural Frequencies of Rotating Bladed Discs Using Clamped-Free Blade Modes," ASME Paper 81-DET-124.

90. Zmitrowicz, A., "A Vibration Analysis of a Turbine Blade System Damped by Dry Friction Forces," Intl. J. Mech. Sci., 23 (12), p 741 (1981).

LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains an article about dynamic applications of piezoelectric crystals.

Dr. M. Cengiz Dökmeci of Istanbul Technical University, Istanbul, Turkey has written Part III of his review of current open literature pertaining to the dynamic applications of piezoelectric crystals. Representative theoretical and experimental papers cover waves and vibrations in piezoelectric one-dimensional and two-dimensional structural elements. New trends of research are pointed out for future applications of piezoelectric crystals.

DYNAMIC APPLICATIONS OF PIEZOELECTRIC CRYSTALS
PART III: EXPERIMENTAL STUDIES

M.C. Dökmeci*

Abstract. This paper presents a review of current open literature pertaining to the dynamic applications of piezoelectric crystals. Representative theoretical and experimental papers cover waves and vibrations in piezoelectric one-dimensional and two-dimensional structural elements. New trends of research are pointed out for future applications of piezoelectric crystals.

EXPERIMENTAL STUDIES

Experiments that have been reported on regularities of wave propagation include ultrasonic nondestructive inspection of materials as well as a number of measurements of the elastic and dielectric constants of piezoelectric materials [142-144] and their dependency on frequency, compressive stresses, and temperature. Experimental studies have generally been limited to cases for which analytical solutions are available and thus have been used for comparison and verification. Experiments have been carried out by standard methods used in each country, for instance, those of the Institute of Radio Engineers (IRE) in the United States of America [25-28] and of the All-Union State Standards (GOST) in the Union of Soviet Socialist Republics [145].

Purely experimental studies. The elliptic polarization of acoustic waves has been studied in certain piezoelectric crystals under the action of an electric field [146], and the sensitivity of rigidly supported piezopolymer membranes has been measured [147]. Optical coherent methods were used to obtain a good picture of the modes of a vibrating piezoceramic disk [148]. The acoustic surface wave and piezoelectric properties of certain ceramics have been examined by suitable experiments [149], as have strain effects on the velocities of surface acoustic waves [150]. Moreover, various methods have been presented for energy trapping of the thickness-extensional mode in a piezoelectric plate [151]. Mention should be also made of experimental studies to determine the influence of the dimensions of piezoelectric plates on the nature of their vibrational modes [152] and to investigate the structure of oscillations in an open acoustic resonator with a reflective piezoelectric plate [153].

Experimental and analytical studies. Theoretical studies with experimental corroboration include amplitude-frequency curves of a tunable high-power radiator formed by two piezoceramic plates separated by a liquid of matching layer [154]. The characteristics of Bleustein-Gulyaev waves on a piezoelectric ceramic with a free surface and a metalized surface have been measured [155], and the generation of this type of surface waves has been examined experimentally and theoretically by using a source of transverse vibrations [156].

With regard to piezoelectric disks, radial modes have been investigated for the most part [157-161]. The frequencies of radial vibration of a thin disk consisting of three concentric annular regions under a nonuniform electric load have been measured according to GOST [157]. Analytical solutions as well as measurements have been made for the frequencies of radial modes of piezoceramic disks with open-circuit electrodes and the nonsymmetric vibrations of a piezoceramic ring polarized along its thickness [158, 159]. Experimental data have been given of investigations for the radial vibrations of a piezoelectric disk [160]. Detailed numerical calculations for the transient voltage across axisymmetrically loaded piezoelectric disks with electroded faces have been reported [161]; corresponding experiments were in satisfactory agreement.

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The response of a piezoceramic cylinder to a laser-excited fluid contained in it has been studied experimentally [162]; analytical results were provided. The low-frequency electroacoustic sensitivity of a composite piezoelectric polymer cylinder has been derived and found to be in close agreement with measured sensitivities [163]. The characterization of radially polarized piezoelectric ceramic tubes has been studied as a function of stress amplitude, orientation, and dimensionality [164].

Lerch [165] presented a theoretical and experimental study of cylindrical and spherical PVDF membranes and calculated their vibration characteristics. He also treated a PVDF membrane supported in its center by a rigid support [166]. Measurements of a flexurally vibrating multi-electrode bar consisting of two identical piezoceramic bars have been compared with an analytical solution obtained by a pertinent equivalent electrical circuit [167].

The generation and detection of acoustic waves in a piezoelectric material by cavity excitation have been discussed and suitable experimental results presented [168]. The propagation of acoustic waves on PVDF piezoelectric films has been investigated by measuring the delay of a burst, as a coupled Lamb and SH wave [169]; the corresponding velocities were measured and used to calculate values of PVDF elastic stiffness coefficients.

Acoustic energy trapping, which results from mass loading and electrical shortening of the metal electrodes of a crystal plate, has been extensively studied in recent years. Such trapping lowers the cut-off frequencies of the infinite partially coated plate in its coated region because vibrational energy is trapped between the electrodes, where it contributes to the charge of the electrodes. Energy trapping occurs in a frequency range between the cut-off frequencies of transverse vibration of the coated and uncoated plate regions. Lee and Haines [73] have elaborated the subject and evaluated the contributions of Mindlin and Haines. Other work has been reported [30], including tests of the effectiveness of energy trapping [170, 171]; good agreement was found between theory and experiment. An analysis of energy trapping effects for SH waves on rotated Y-cut quartz, including experimental results has been presented [172]. The energy trapping of thickness-extensional vibrations in a thin piezoceramic strip has been studied and experimentally verified [173]; these results have clarified the mechanism of energy trapping.

CONCLUDING REMARKS

This paper is intended to introduce new developments to and provide guidance for interested readers in the field of piezoelectricity. The paper presents the current status of investigations concerning dynamic applications of piezoelectric crystals. Both the analytical and experimental characterizations of piezoelectric crystals have been reviewed for such structural elements as bars, disks, plates, cylindrical and spherical shells, tubes, and layered structural elements as well as for acoustic surface waves and energy trapping; representative recent references are cited.

Notable strides have been made in recent years in the analysis and design of structural elements in piezoelectric devices. However, their diverse and increasing use will require additional and more extensive analytical research as well as experimental corroboration to elaborate the fundamental characteristics of piezoelectric structural elements for high performance and design. Such research efforts should focus on energy trapping and acoustic emission, particularly waveguiding or ducting.

Additional studies are needed for thin piezoelectric films, which are used to produce very high-frequency waves. Further research on the analysis of fracture in piezoelectric materials of biological origin, especially bones, will attract attention and could have important clinical applications. Moreover, a challenging area of research involves polar and non-local as well as probabilistic and relativistic aspects of piezoelectricity. Also of interest are stability and static problems that have been studied for only a few specific cases thus far.

In conclusion, due to current demands, both dynamic and static applications of piezoelectric crystals appear to be a promising and evidently open field for further research.

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REFERENCES

1. Cady, W.G., Piezoelectricity, Vols 1 and 2, Dover Publications (1964).

2. Curie, P., Oeuvres de Pierre Curie, Gauthier-Villars & Cie (1908).

3. Voigt, W., Lehrbuch der Kristallphysik, Teubner (1910).

4. Mason, W.P., Piezoelectric Crystals and Their Applications to Ultrasonics, D. van Nostrand Co. (1950).

5. Zheludev, I.S., Physics of Crystalline Dielectrics, Vols 1 and 2, Plenum Press (1971).

6. Bergmann, L., Der Ultraschall und seine Anwendung in Wissenschaft und Technic, Hirzel (1954); Eng. Tr., Ultrasonics and Their Scientific and Technical Applications, John Wiley and Sons (1968).

7. Mason, W.P., "Piezoelectricity, Its History and Applications," J. Acoust. Soc. Amer., 70 (6), pp 1561-1566 (1981).

8. Nye, J.F., Physical Properties of Crystals, The Clarendon Press (1957).

9. Venkataraman, G., Feldkamp, L.A., and Sahni, V.C., Dynamics of Perfect Crystals, The M.I.T. Press (1975).

10. Shubnikov, A.V., Zheludev, I.S., Konstantinova, V.P., and Silvestrova, I.M., Issledovanie Piezoelektritcheskikh Textur, Izd-vo AN SSSR (1955); French Tr., Etude des Textures Piezoelectriques, Dunod (1958).

11. Jaffe, B., Cook, W.R., and Jaffe, H., Piezoelectric Ceramics, Academic Press (1971).

12. Kagawa, Y. and Hatakeyama, T., "Piezoelectric Effect in Liquid Crystals," J. Sound Vib., 53 (4), pp 585-593 (1977).

13. Bazhenov, V.A., Piezoelectric Properties of Wood, Consultants Bureau (1961).

14. Fukada, E., "Mechanical Deformation and Electrical Polarizstion in Biological Substances," Biorheology, 5 (1), pp 199-208 (1968).

15. Fukada, E., "Piezoelectricity in Polymers and Biological Substances," Ultrasonics, 6 (4), pp 229-234 (1968).

16. Deri, M., Ferroelectric Ceramics, Maclaren (1966).

17. Van Randeraat, J. (editor), Piezoelectric Ceramics, Philips Gloeilampenfabrienken (1968).

18. Berlincourt, D., "Piezoelectric Ceramics: Characteristics and Applications," J. Acoust. Soc. Amer., 70 (6), pp 1586-1595 (1981).

19. Sessler, G.M., "Piezoelectricity in Polyvinylidenefluoride," J. Acoust. Soc. Amer., 70 (6), pp 1596-1608 (1981).

20. Jona, F. and Shirane, G., Ferroelectric Crystals, Pergamon Press (1962).

21. Grindlay, J., An Introduction to the Phenomenological Theory of Ferroelectricity, Pergamon Press (1970).

22. Forsbergh Jr., P.W., "Piezoelectricity, Electrostriction and Ferroelectricity," Encyclopedia of Physics, Vol XVII: Dielectrics, pp 264-392, Springer-Verlag (1956).

23. Berlincourt, D.A., Curran, D.R., and Jaffe, H., Piezoelectric and Piezomagnetic Materials and Their Function in Transducers," Physical Acoustics, Vol 1 - Part 1, pp 169-270, Academic Press (1964).

24. Bechmann, R., Hearmon, R.F.S., and Kurtz, S.K., Elastic, Piezoelectric, Piezooptic and Electrooptic Constants of Crystals, Numerical Data and Functional Relationships in Science and Technology, Vol 1, Springer-Verlag (1966).

25. "*IRE Standards on Piezoelectric Crystals*, 1949," Proc. IRE, 37, pp 1378-1395 (1949).

26. "IRE Standards on Piezoelectric Crystals -- The Piezoelectric Vibrator: Definitions and Meth-

ods of Measurement, 1957," Proc. IRE, 45, pp 353-358 (1957).

27. "IRE Standards on Piezoelectric Crystals: Determination of the Elastic, Piezoelectric, and Dielectric Constants -- The Electromechanical Coupling Factor, 1958," Proc. IRE, 46, pp 764-778 (1958).

28. "IRE Standards on Piezoelectric Crystals: Measurements of Piezoelectric Ceramics, 1961," Proc. IRE, 49, pp 1161-1169 (1961).

29. Mason, W.P., Crystal Physics of Interaction Processes, Academic Press (1966).

30. Holland, R. and Eer Nisse, E.P., Design of Resonant Piezoelectric Devices, Res. Monog. No. 56, The M.I.T. Press (1969).

31. Nagy, N.F.L. and Joyce, G.C., "Solid State Control Elements Operating in Piezoelectric Principles," Physical Acoustics, Vol IX, pp 129-165, Academic Press (1972).

32. Domarkas, V.I. and Kazys, R.J., Kontroles-matavimo Pjezoelektriniai Keitikliai (Russian), (Piezoelectric Transducers for Measuring Devices), Mintis (1975).

33. Keuning, D.H., "Approximate Equations for the Flexure of Thin, Incomplete, Piezoelectric Bimorphs," J. Engrg. Math., 5 (4), pp 307-319 (1971).

34. Mindlin, R.D., "Torsion and Flexure of Piezoelectric Crystal Bars," Application of Elastic Waves in Electrical Devices, Non-Destructive Testing, and Seismology, pp 83-99, NSF Engrg. Mech. Sec., Solid Mech. Prog. (1976).

35. Parton, V.Z., "Fracture Mechanics of Piezoelectric Materials," Acta Astronautica, 3 (9/10), pp 671-683 (1976).

36. Kosmodamianskii, A.S., Kravchenko, A.P., and Lozhkin, V.N., "Electroelastic State of a Piezoelectric Half Plane with Elliptical Core," Sov. Appl. Mech., 14 (10), pp 1073-1078 (1978); Prikl. Mekh., 14 (10), pp 75-81.

37. Ricketts, D., "Model for a Piezoelectric Polymer Flexural Plate Hydrophone," J. Acoust. Soc. Amer., 70 (4), pp 929-935 (1981).

38. Landau, L.D. and Lifshitz, E.M., Electrodynamics of Continuous Media, Addison-Wesley (1960).

39. Truesdell, C. and Toupin, R., "Classical Field Theories," Encyclopedia of Physics, Vol III/1: Principles of Classical Mechanics and Field Theory, pp 226-793, Springer-Verlag (1960).

40. Tamm, I.E., Principles of the Theory of Electricity, Fizmatgiz (1965).

41. Stratton, J.A., Electromagnetic Theory, McGraw-Hill (1941).

42. Parkus, H., (editor), Electromagnetic Interactions in Solids, Springer-Verlag (1979).

43. Tiersten, H.F., "The Radiation and Confinement of Electromagnetic Energy Accompanying the Oscillations of Piezoelectric Crystal Plates," Recent Advances in Engineering Science, Vol V, Part I, pp 63-90, Gordon and Breach (1970).

44. Mindlin, R.D., "On the Equations of Motion of Piezoelectric Crystals," Problems of Continuum Mechanics, pp 282-290, SIAM (1961).

45. Tiersten, H.F., Linear Piezoelectric Plate Vibrations, Plenum Press (1969).

46. Nowacki, W., "Foundations of Linear Piezoelectricity," Electromagnetic Interactions in Solids, pp 105-157, Springer-Verlag (1979).

47. Thurston, R.N., "Waves in Solids," Encyclopedia of Physics, Vol VIa/4, Mechanics of Solids, pp 109-308, Springer-Verlag (1974).

48. Nelson, D.F., "Theory of Nonlinear Electoacoustics of Dielectric, Piezoelectric, and Pyroelectric Crystals," J. Acoust. Soc. Amer., 63 (6), pp 1738-1748 (1978).

49. Gagnepain, J.J. and Besson, R., "Nonlinear Effects in Piezoelectric Quartz Crystals,"

Physical Acoustics, Vol X1, pp 245-288, Academic Press (1975).

50. Mindlin, R.D., "Equations of High Frequency Vibrations of Thermopiezoelectric Crystal Plates," Intl. J. Solids Struc., 10, pp 625-637 (1974).

51. Nowacki, W., "Some General Theorems of Thermopiezoelectricity," J. Thermal Stresses, 1 (2), pp 171-182 (1978).

52. Lothe, J. and Barnett, D.M., "On the Existence of Surface Wave Solutions in Piezoelectric Crystals, An Example of Non-existence," Wave Motion, 1 (1), pp 107-112 (1979).

53. Mindlin, R.D., Theory of Beams and Plates, Lecture notes at Columbia University (1956).

54. Gubenkov, A.N., Kirichenko, V.F., Kulikov, E.L., and Pavlov, S.P., "A Variational Principle for Problems in the Analysis of Piezoelectric Devices with Acoustoelectric Coupling," Sov. Phys. Acoust., 24 (2), pp 111-114 (1978); Akust. Zh., 24, pp 195-202.

55. Dokmeci, M.C., "Theory of Vibrations of Coated, Thermopiezoelectric Laminae," J. Math. Phys., 19 (1), pp 109-126 (1978).

56. Dökmeci, M.C., "Recent Advances: Theory of Vibrations of Piezoelectric Crystals," Intl. J. Engrg. Sci., 18 (3), pp 431-448 (1980).

57. Dökmeci, M.C., "Variational Principles in Piezoelectricity," L. Al Nuovo Cimento, 7 (11), pp 449-454 (1973).

58. Tiersten, H.F., "Natural Boundary and Initial Conditions from a Modification of Hamilton's Principle," J. Math. Phys., 9 (9), pp 1445-1451 (1968).

59. Kudriavtsev, B.A., Parton, V.Z., and Rakitin, V.I., "Fracture Mechanics of Piezoelectric Materials. Axisymmetric Crack on the Boundary with a Conductor," Sov. Appl. Math. Mech., 39 (2), pp 328-338 (1975); PMM, 39, pp 352-362.

60. Carlson, D.E., "Linear Thermoelasticity," Encyclopedia of Physics, Vol VIa/2, Mechanics of Solids, pp 297-345, Springer-Verlag (1972).

61. Muller, L., "The Reciprocal Theorem for Piezoelectrics as Interpreted by R.D. Mindlin," Bull. Acad. Polonaise Sci., Ser. Sci. Techn., 28 (1/2), pp 27-32 (1980).

62. Brzezinski, A., "Reciprocal Theorem for Piezoelectric Thermoelasticity," Bull. Acad. Polonaise Sci., Ser. Sci. Techn., 26 (2), pp 143-150 (1978).

63. Tanaka, K. and Tanaka, M., "A Boundary Element Formulation in Linear Piezoelectric Problems," Z. angew Math. Phys., 31 (5), pp 568-580 (1980).

64. Alekseev, B.N., Dianov, D.B., and Karuzo, S.P., "Tapered Piezoelectric Bar Transducer with Transverse Polarization of the Piezoceramic," Sov. Phys. Acoust., 23 (1), pp 1-4; Akust. Zh., 23, pp 1-8 (1977).

65. Alekseev, B.N., Dianov, B.N., and Karuzo, S.P., "Composite Tapered Piezoceramic Bar Transducer," Sov. Phys. Acoust., 24 (2), pp 98-101; Akust. Zh., 24, pp 168-173 (1978).

66. Bondarenko, A.A., Kutsenko, G.V., and Ulitko, A.F., "Amplitudes and Phases of Longitudinal Vibrations of Piezoceramic Rods with Account of Variable Mechanical Quality Factor," Sov. Appl. Mech., 16 (11), pp 1001-1004 (1981), Prikl. Mekh., 16 (11), pp 84-88.

67. Busher, M.K. and Syrkin, L.N., "Application of the Reissner Mixed Variational Principle from the Theory of Elasticity for the Calculation of Inhomogeneous Piezoceramic Bar Transducers," Sov. Phys. Acoust., 24 (5), pp 374-378 (1979); Akust. Zh., 24, pp 664-672.

68. Cherpak, V.A., "Dynamic Lumped Parameters of Composite Piezoelectric Transducers," Sov. Phys. Acoust., 23 (3), pp 246-250 (1977); Akust. Zh., 23, pp 443-449.

69. Das, A. and Ray, A., "Forced Transient Motion of a Piezoelectric Bar and Its Voltage Re-

sponse," Indian J. Tech., 18, pp 349-353 (1980).

70. Zharii, O.Yu., "Discharge of a Piezoceramic Rod in Shock Loading," Sov. Appl. Mech., 17 (3), pp 284-288 (1981); Prikl. Mekh., 17 (3), pp 98-103.

71. Dokmeci, M.C., "A Theory of High Frequency Vibrations of Piezoelectric Crystal Bars," Intl. J. Solids Struc., 10 (4), pp 401-409 (1974).

72. Mindlin, R.D., "High Frequency Vibrations of Piezoelectric Crystal Plates," Intl. J. Solids Struc., 8, pp 895-906 (1972).

73. Lee, P.C.Y. and Haines, D.W., "Piezoelectric Crystals and Electro-Elasticity," R.D. Mindlin and Applied Mechanics, pp 227-253, Pergamon Press (1974).

74. Sinha, B.K. and Stevens, D.S., "Thickness-shear Vibrations of a Beveled AT-cut Quartz Plate," J. Acoust. Soc. Amer., 66 (1), pp 192-196 (1979).

75. Kasatkin, B.A. and Lebedev, V.G., "Spectrum of Natural Frequencies of a Loaded Piezoelectric Plate with a Transition Layer," Sov. Phys. Acoust., 25 (3), pp 224-227 (1979), Akust. Zh., 25, pp 395-400.

76. Aronov, B.S. and Nikitin, L.B., "Calculation of the Flexural Modes of Piezoceramic Plates," Sov. Phys. Acoust., 27 (5), pp 382-387 (1982), Akust. Zh., 27, pp 687-696.

77. Lozhkin, V.N., "Low-frequency Vibrations of Piezocrystalline Plates," Sov. Appl. Mech., 17, pp 673-677 (1982), Prikl. Mekh., 17, pp 89-93.

78. Schwarz, R., "Dreidimensionales Modell einer quaderformigen Piezokeramik fur longitudinale Wellenausbreitung," Acustica, 47 (4), pp 275-282 (1981).

79. Shnitser, P.I., "Analysis of Oscillations in an Open Acoustic Resonator with Reflective Piezoelectric Transducers," Sov. Phys. Acoust., 26 (3), pp 244-247 (1980), Akust. Zh., 26, pp 446-452.

80. Gitis, M.B. and Shenker, A.A., "Pulsed Operation of a Flat Piezoelectric Transducer," Sov. Phys. Acoust., 27 (6), pp 469-472 (1982); Akust. Zh., 27, pp 848-854.

81. Kagawa, Y. and Yamabuchi, T., "Finite Element Simulation of a Composite Piezoelectric Ultrasonic Transcucer," IEEE SU-26 (2), pp 81-88 (1979).

82. Das, A. and Ray, A., "Transient Stresses and Voltage Developed in a Spinning Disc of Radially Inhomogeneous Piezoelectric Material," J. Sound Vib., 67 (1), pp 75-87 (1979).

83. Vovkodav, I.F., Karlash, V.L., and Ulitko, A.F., "Axisymmetric Vibrations of Thin Piezoceramic Disks with Split Electrodes," Sov. Appl. Mech., 15 (2), pp 148-152 (1979); Prikl. Mekh., 15, pp 77-82.

84. Aronov, B.S., "Calculation of the Radial Modes of Piezoceramic Disks with Axisymmetrical Electrodes," Sov. Appl. Mech., 16 (11), pp 986-992 (1981); Prikl. Mekh., 16, pp 65-72.

85. Kirichok, I.F., "Heat Release Associated with the Electroelastic Modes of Piezoelectric Ceramic Disks," Sov. Appl. Mech., 16 (10), pp 902-905 (1981); Prikl. Mekh., 16, pp 82-86.

86. Adelman, N.T. and Stavsky, Y., "Flexural-extensional Behavior of Composite Piezoelectric Circular Plates," J. Acoust. Soc. Amer., 67 (3), pp 819-822 (1980).

87. Schwarzenbach, H.U., Lechner, H., Steinle, B., Baltes, H.P. and Schwendmann, P., "Calculation of Vibrations of Thick Piezoceramic Disk Resonators," Appl. Phys. Lett., 38 (11), pp 854-855 (1981).

88. Barilov, E.S., Vassergiser, M.E., and Dorosh, A.G., "Calculation of Equivalent-Circuit Parameters for a Radially Polarized Piezoceramic Sphere," Sov. Phys. Acoust., 25 (3), pp 199-202 (1979); Akust. Zh., 25, pp 352-357.

89. Borisyuk, A.I. and Kirichok, I.F., "Steady-State Radial Vibrations of Piezoceramic Spheres in Compressible Fluid," Sov. Appl. Mech.,

15 (10), pp 936-940 (1980); Prikl. Mekh., 15 (10), pp 45-49.

90. Kirichok, I.F., "Numerical Solution of Problems of the Electroelastic Oscillation of a Cylinder and a Sphere," Sov. Appl. Mech., 16 (2), pp 121-125 (1980); Prikl. Mekh., 16 (2), pp 45-50.

91. Gololobov, V.I., "Numerical Analysis of Piezoelectric Ceramic Shells of Revolution," Sov. Appl. Mech., 17 (4), pp 339-343 (1981); Prikl. Mekh., 17 (4), pp 38-42.

92. Burt, J.A., "The Electroacoustic Sensitivity of Radially Polarized Ceramic Cylinders as a Function of Frequency," J. Acoust. Soc. Amer., 64 (6), pp 1640-1644 (1978).

93. Busher, M.K., "Dynamic Equations for a Piezoceramic Radiating Transducer Having an Inhomogeneous Structure," Sov. Phys. Acoust., 24 (6), pp 476-479 (1979); Akust. Zh., 24, pp 835-843.

94. Abdulgalimov, A.M., "Vibration of Cylindrical Piezocoverters of Finite Size," Moscow Univ. Mech. Bull., 36 (2), pp 38-42 (1981); Vestnik Moskovskogo Univ. Mekh., 36 (2), pp 71-76.

95. Kasatkin, B.A., "Generalized Orthogonality Relations for the Normal Modes of a Piezoelectric Waveguide and Their Application in the Theory of Resonators," Sov. Phys. Acoust., 27 (4), pp 290-292 (1982); Akust. Zh., 27, pp 520-525.

96. Sarma, K.V., "Torsional Wave Motion of a Finite Inhomogeneous Piezoelectric Cylindrical Shell," Intl. J. Engrg. Sci., 18, pp 449-454 (1980).

97. Srinivasamoorthy, V.R. and Anandam, C., "Torsional Wave Propagation in an Infinite Piezoelectric Cylinder (622) Crystal Class," J. Acoust. Soc. Amer., 67 (6), pp 2034-2035 (1980).

98. Paul, H.S. and Raju, D.P., "Asymptotic Analysis of the Torsional Modes of Wave Propagation in a Piezoelectric Solid Circular Cylinder of (622) Class," Intl. J. Engrg. Sci., 19, pp 1069-1076 (1981).

99. Dianov, D.B., Zadirienko, I.M., and Kuz'menko, A.G., "Acoustical Characteristics of a Baffled Cylindrical Piezoelectric Transducer Radiating through a Liquid Layer," Sov. Phys. Acoust., 27 (3), pp 197-199 (1981); Akust. Zh., 27, pp 358-362.

100. Lakes, R., "Shape-Dependent Damping in Piezoelectric Solids," IEEE SU-27 (4), pp 208-213 (1980).

101. Martin, G.E., "Dielectric, Piezoelectric, and Elastic Losses in Longitudinally Polarized Segmented Ceramic Tubes," U.S. Navy J. Underwater Acoust., 15, pp 329-332 (1965).

102. Sittig, E.K., "Design and Technology of Piezoelectric Transducers for Frequencies above 100 MHz," Physical Acoustics, Vol. IX, pp 221-275, Academic Press (1972).

103. Kasatkin, B.A., "Generalized Orthogonality of Normal Modes of Layered Piezoelectric Transducers," Sov. Phys. Acoust., 25 (5), pp 402-405 (1980); Akust., Zh., 25, pp 710-716.

104. Kasatkin, B.A., "Pulse and Transient Responses of a Water-Loaded Layered Piezoelectric Transducer," Sov. Phys. Acoust., 27 (1), pp 85-86 (1981); Akust. Zh., 27, pp 153-155.

105. Mindlin, R.D., An Introduction to the Mathematical Theory of Vibrations of Elastic Plates, U.S. Army Signal Corps Engrg. Lab., Fort Monmouth (1955).

106. Bugdayci, N. and Bogy, D.B., "A Two-Dimensional Theory for Piezoelectric Layers Used in Electro-mechanical Transducers - I: Derivation and II: Applications," Intl. J. Solids Struc., 17 (12), pp 1159-1178 and 1179-1202 (1981).

107. Bugdayci, N. and Bogy, D.B., "A Two-Dimensional Theory for Piezoelectric Layers Used in Electro-mechanical Transducers - II: Applications," Intl. J. Solids Struc., 17 (12), pp 1179-1202 (1981).

108. Boucher, D., Lagier, M., and Maerfeld, C., "Computation of the Vibrational Modes for Piezoelectric Array Transducers Using a Mixed Finite Element-Perturbation Method," IEEE SU-28 (5), pp 318-330 (1981).

109. Stepanishen, P.R., "Pulsed Transmit/Receive Response of Ultrasonic Piezoelectric Transducers," J. Acoust. Soc. Amer., 69 (6), pp 1815-1827 (1981).

110. Wellekens, C.J., "Vibrations of Backed Piezoceramic Disk-Transducers with Annular Electrodes and Matching Layers - Part I," IEEE SU-29 (1), pp 26-37 (1982).

111. Wellekens, C.J., "Vibrations of Backed Piezoceramic Disk-Transducers with Annular Electrodes and Matching Layers - Part II," IEEE SU-29 (1), pp 37-42 (1982).

112. White, R.M., "Surface Elastic Waves," Proc. IEEE, 58, pp 1238-1276 (1970).

113. Viktorov, I.A., "Types of Acoustic Surface Waves in Solids (Review)," Sov. Phys. Acoust., 25 (1), pp 1-9 (1979); Akust. Zh., 25, pp 1-17.

114. Auld, B.A., Acoustic Fields and Waves in Solids, Vols. 1 and 2, John Wiley and Sons (1973).

115. Dieulesaint, E. and Royer, D., Elastic Waves in Solids, John Wiley and Sons (1980).

116. Farnell, G.W., "Types and Properties of Surface Waves," Acoustic Surface Waves, pp 13-60, Springer-Verlag (1978).

117. Gerard, H.M., "Principles of Surface Wave Filter Design," Acoustic Surface Waves, pp 61-96, Springer-Verlag (1978).

118. Ash, E.A., "Fundamentals of Signal processing Devices," Acoustic Surface Waves, pp 97-185, Springer-Verlag (1978).

119. Oliner, A.A., "Waveguides for Surface Waves," Acoustic Surface Waves, pp 187-223, Springer-Verlag (1978).

120. Slobodnik, Jr., A.J., "Materials and Their Influence on Performance," Acoustic Surface Waves, pp 225-303, Springer-Verlag (1978).

121. Smith, H.I., "Fabrication Techniques for Surface Wave Devices," Acoustic Surface Waves, pp 305-324, Springer-Verlag (1978).

122. Sinha, B.K. and Tiersten, H.F., "On the Influence of a Flexural Biasing State on the Velocity of Piezoelectric Surface Waves," Wave Motion, 1 (1), pp 37-51 (1979).

123. Datta, S., Theory of Guided Acoustic Waves in Piezoelectric Solids, Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign (1979).

124. Shimizu, Y. and Terazaki, A., "Attenuation and Velocity of Surface Waves on a Piezoelectric Substrate Coated with Admittance Films," J. Acoust. Soc. Amer., 66 (3), pp 806-810 (1979).

125. Nalamwar, A.L. and Epstein, M., "Surface Acoustic Waves in Strained Media," J. Appl. Phys., 47 (1), pp 43-48 (1976).

126. Tsutsumi, M. and Kumagai, N., "Behavior of Bleustein-Gulyaev Waves in a Periodically Corrugated Piezoelectric Crystal," IEEE MTT-28 (6), pp 627-632 (1980).

127. Pyatakov, P.A., "Structure of the Wave Field Associated with Excitation of a Gulyaev-Bleustein Wave," Sov. Phys. Acoust., 24 (3), pp 218-221 (1978); Akust. Zh., 24, pp 394-400.

128. Morocha, A.K., Ovsyannikova, O.B., and Shermergor, T.D., "Amplification of Stonely Waves at an Interface between a Piezoelectric Semiconductor and a Dielectric Crystal," Sov. Phys. Acoust., 24 (3), pp 212-214 (1978); Akust. Zh., 24, pp 383-387.

129. Viktorov, I.A. and Pyatakov, P.A., "Acoustoelectric Interactions on Cylindrical Surfaces of Piezoelectric Semiconductors," Sov. Phys. Acoust., 25 (2), pp 159-161 (1979); Akust. Zh., 25, pp 290-293.

130. Viktorov, I.A. and Pyatakov, P.A., "Influence of the Piezoelectric Effect on the Properties of Transverse Surface Waves on Cylindrical Surfaces of Crystals," Sov. Phys. Acoust., 24 (1), pp 28-30 (1978); Akust. Zh., 24, pp 53-58.

131. Gulyaev, Yu.V. and Plesskii, V.P., "Acoustic Gap Waves in Piezoelectric Materials," Sov. Phys. Acoust., 23 (5), pp 410-413 (1978); Akust. Zh., 23, pp 716-723.

132. Mozhaev, V.G., "Shear-Wave Convolution in a Layered Piezoelectric-Semiconductor Structure," Sov. Phys. Acoust., 27 (2), pp 156-159 (1981); Akust. Zh., 27, pp 285-290.

133. Horvat, P. and Auld, B.A., "Attenuation des Ondes de Cisaillement Horizontal et des Ondes de Lamb dans les Films Piézoélectriques de Poly (fluorure de vinylidène)," C.R. Acad. Sci., 290, Série B, pp 333-336 (1980).

134. Noorbehesht, B. and Wade, G., "Reflection and Transmission of Plane Elastic Waves at the Boundary between Piezoelectric Materials and Water," J. Acoust. Soc. Amer., 67 (6), pp 1947-1953 (1980).

135. Burlak, G.N., Kotsarenko, N., Ya., and Pustyl'nik, T.N., "Parametric Excitation of Acoustic Waves in Bounded Piezoelectrics," Sov. Phys. Acoust., 22 (6), pp 1059-1061 (1980); Akust. Zh., 22, pp 1825-1828.

136. Burlak, G.N. and Kotsarenko, N.Ya., "Generation of Acoustic Waves in Crystals with the Nonlinear Piezoelectric Effect in the Presence of Reflection," Sov. Phys. Acoust., 27 (1), pp 81-83 (1981), Akust. Zh., 27, pp 148-150.

137. Taylor, D.B. and Crampin, S., "Surface Waves in Anisotropic Media: Propagation in a Homogeneous Piezoelectric Halfspace," Proc. Royal Soc. London, Ser. A 364, pp 161-179 (1978).

138. Mozhaev, V.G. and Solodov, I. Yu, "Second-Harmonic Generation of Acoustic Surface Waves in a Layered Piezoelectric Insulator-Semiconductor Structure," Sov. Phys. Acoust., 26 (3), pp 236-240 (1980); Akust. Zh., 26, pp 433-439.

139. Tiersten, H.F., Sinha, B.K., and Meeker, T.R., "Intrinsic Stress in Thin Films Deposited on Anisotropic Substrates and Its Influence on the Natural Frequencies of Piezoelectric Resonators," J. Appl. Phys., 52 (9), pp 5614-5624 (1981).

140. Pouget, J. and Maugin, G.A., "Piezoelectric Rayleigh Waves in Elastic Ferroelectrics," J. Acoust. Soc. Amer., 69 (5), pp 1319-1325 (1981).

141. Kazhis, R.I., "Frequency Responses of a Piezoelectric Shear-Mode Receiver with an Inhomogeneous Electric Field," Sov. Phys. Acoust., 26 (1), pp 39-43 (1980); Akust. Zh., 26, pp 74-83.

142. Korobov, A.I. and Lyamov, V.E., "Nonlinear Piezoelectric Coefficients of $LiNbO_3$," Sov. Phys. Solid State, 17 (5), pp 932-933 (1975); Fiz. Tverd. Tela., 17, pp 1448-1450.

143. Nakagawa, Y., Yamanouchi, K., and Shibayama, K., "Third-Order Elastic Constants of Lithium Niobate," J. Appl. Phys., 44 (9), pp 3969-3974 (1973).

144. Bell, J.F., "The Experimental Foundations of Solid Mechanics," Encyclopedia of Physics, Vol. VIa/1, Mechanics of Solids I, pp 1-813, Springer-Verlag (1973).

145. GOST (All-Union State Standard) 12370-72: Piezoceramic Materials. Testing Methods (in Russian), Izd. Standartov, Moscow (1973).

146. Baryshnikova, L.F. and Lyamov, V.E., "Elliptical Polarization of Acoustic Waves in Piezoelectric Crystals under the Action of an Electric Field," Sov. Phys. Acoust., 26 (6), pp 465-467 (1981); Akust. Zh., 26, pp 824-827.

147. Lerch, R. and Sessler, G.M., "Microphones with Rigidly Supported Piezopolymer Membranes," J. Acoust. Soc. Amer., 67 (4), pp 1379-1381 (1980).

148. Rosenberg, A. and Politch, J., "Investigation of of a Vibrating Piezoelectric Ceramic Disk by Synthesis of Optical Coherent Methods," Exptl. Mech., 20 (4), pp 140-144 (1980).

149. Ito, Y., Nagatsuma, K., Takeuchi, H.. and Jyomura, S., "Surface Acoustic Wave and Piezoelectric Properties of (Pb, Ln) (Ti, Mn)O_3 Ceramics (Ln = rare earth)," J. Appl. Phys., 52 (7), pp 4479-4486 (1981).

150. Takeuchi, H. and Yamauchi, H., "Strain Effects on Surface Acoustic Wave Velocities in Modified $PbTiO_3$ Ceramics," J. Appl. Phys., 52 (10), pp 6147-6150 (1981).

151. Tanaka, H., Shimizu, H., and Yamada, K., "Methods for Energy Trapping of Thickness Extensional Mode and Thickness Shear Mode in Piezoelectric Ceramic Plate," Elec. Comm. Japan, 62-A (8), pp 10-19 (1981).

152. Tsok, O.E., "Influence of the Dimensions of Piezoelectric Plates on the Nature of Their Vibrational Modes," Sov. Phys. Acoust., 26 (6), pp 524-525 (1981), Akust. Zh., 26, pp 929-931.

153. Magdich, L.N. and Shnitser, P.I., "Structure of the Oscillations in an Open Acoustic Resonator with a Reflective Piezoelectric Transducer," Sov. Phys. Acoust., 27 (4), pp 313-315 (1982), Akust. Zh., 27, pp 562-566.

154. Lanina, E.P., "Tunable High-Frequency High-Power Piezoceramic Radiator," Sov. Phys. Acoust., 24 (3), pp 207-209 (1978); Akust. Zh., 24, pp 372-375.

155. Pajewski, W., "Transversal Bleustein-Gulayev (B.G.) Surface Waves on a Piezoelectric Ceramic," Arch. Acoust., 2 (3), pp 197-206 (1977).

156. Kinh, N.V. and Pajewski, W., "Generation of Acousto-electrical Waves Using a Source of Transverse Vibrations," Arch. Acoust., 5 (3), pp 261-274 (1980).

157. Karlash, V.L., Klyushnichenko, V.A., Kramarov, Yu.A., and Ulitko, A.F., "Radial Vibrations of Thin Piezoceramic Disks under a Nonuniform Electric Load," Sov. Appl. Mech., 13 (8), pp 784-788 (1977); Prikl. Mekh., 13, pp 56-62.

158. Karlash, V.L., "Radial Modes of Piezoceramic Disks with Open-Circuit Electrodes," Sov. Appl. Mech., 17 (9), pp 836-839 (1982); Prikl. Mekh., 17, pp 83-87.

159. Karlash, V.L., "Nonsymmetric Vibrations of Piezoelectric Ceramic Rings Polarized along the Thickness," Sov. Appl. Mech., 14 (12), pp 1303-1308 (1979); Prikl. Mekh., 14, pp 88-94.

160. Golanowski, J. and Gudra, T., "Ultrasonic Transducers Using Radial Vibrations of a Piezoelectric Disk," Arch. Acoust., 4 (3), pp 245-255 (1979).

161. Bogy, D.B. and Miu, D.K.K., "Transient Voltage across Axisymmetrically Loaded Piezoelectric Disks with Electroded Faces," J. Acoust. Soc. Amer., 71 (2), pp 487-497 (1982).

162. Burt, J.A., "The Response of a Fluid-filled Piezoceramic Cylinder to Pressure Generated by an Axial Laser Pulse," J. Acoust. Soc. Amer., 65 (5), pp 1164-1169 (1979).

163. Ricketts, D., Electroacoustic Sensitivity of Composite Piezoelectric Polymer Cylinders," J. Acoust. Soc. Amer., 68 (4), pp 1025-1029 (1980).

164. Tims, A.C., "Effects of Multidimensional Stress on Radially Polarized Piezoelectric Ceramic Tubes," J. Acoust. Soc. Amer., 70 (1), pp 21-28 (1981).

165. Lerch, R., "Electroacoustic Transducers Using Piezoelectric Polyvinylidenefluoride Films," J. Acoust. Soc. Amer., 66 (4), pp 952-954 (1979).

166. Lerch, R., "Piezopolymer Transducers with Point-Supported Membranes," J. Acoust. Soc. Amer., 70 (5), pp 1229-1234 (1981).

167. Sheiko, Yu.A., "Equivalent Circuit of a Flexurally Vibrating Multielectrode Piezoelectric Bar," Sov. Phys. Acoust., 24 (2), pp 154-156 (1978); Akust. Zh., 24, pp 279-283.

168. McNab, A. and Richter, J., "Electromagnetic Field Reciprocity Applied to the Excitation and Detection of Elastic Waves in an Electromagnetic Cavity Resonator," J. Acoust. Soc. Amer., 66 (6), pp 1593-1600 (1979).

169. Horvat, P. and Auld, B.A., "Propagation d'ondes de Cisaillement et d'ondes de Lamb dans les Films Piézoélectriques de Poly(fluorure de vinylidène)," C.R. Acad. Sci., 290, Série B, pp 1-4 (1980).

170. Tiersten, H.F., McDonald, J.F., Tse, M.F., and Das, P., "Monolithic Mosaic Transducer Utilizing Trapped Energy Modes," Acoustical Holography, Vol. 7, pp 405-422, Plenum Publ. Corp. (1977).

171. Tiersten, H.F., Sinha, B.K., McDonald, J.F., and Das, P.K., "On the Influence of a Tuning Inductor on the Bandwidth of Extensional Trapped Energy Mode Transducers," IEEE Ultrasonics Symp. Proc., pp 163-166 (1978).

172. Lee, D.L., "Analysis of Energy Trapping Effects for SH-Type Waves on Rotated Y-Cut Quartz," IEEE SU-28 (5), pp 330-341 (1981).

173. Watanabe, H., Nakamura, K., and Shimizu, H., "A New Type of Energy Trapping Caused by Contributions from the Complex Branches of Dispersion Curves," IEEE SU-28 (4), pp 265-270 (1981).

BOOK REVIEWS

INDUSTRIAL PNEUMATIC SYSTEMS: NOISE CONTROL AND ENERGY CONSERVATION

D. Oviatt and R.K. Miller
Fairmont Press, Atlanta, GA
1981, 212 pp, $27.95

This book covers the general area of industrial pneumatics. It discusses the important aspects of energy costs of pneumatic systems and the noise associated with them. The topics included in the book cover the many types of air compressors (rotary, portable), air intake and distribution systems, pneumatic tools and devices (rotary, percussive), muffler design, and maintenance for energy conservation and noise control. Appendices contain noise emission standards in addition to test codes.

A good reference section is included for the reader with an interest in *further research*. A *short index* is also included. This text, in comparison with other books written by either of the authors, is vastly improved in terms of the quality of photographs, illustrations, and tables. However, the information contained within will be disappointing to anyone other than a novice in the area of noise control.

A reader, when seeing the words noise control in the title, would expect to see solutions to the noise problems associated with pneumatic systems. The only treatment that goes beyond anything but a cursory review is the chapter on muffler design. Even this coverage is uneven and lacks clarity. The only contribution is the rank-order comparison between mufflers, which was referenced material and not an original contribution from the authors.

This text is lacking the features that would justify a strong recommendation for purchase by an engineer.

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COMPUTER AIDED DESIGN AND MANUFACTURE

C.B. Besant
Halsted Press, Div. of John Wiley & Sons,
New York, NY, 1980, 170 pp, $47.95

This book points out the difficulty of presenting up-to-date product-related material in the fast changing world of CAD/CAM: the system described by the author in 1980 was technologically obsolete by 1982. However, the book does provide the reader with an overview of the hardware and software components that, taken together, provide the capability for computer aided drafting.

Besant begins with a traditional introduction to CAD; he describes the technological development of graphic display devices, early SKETCHPAD software, and *minicomputers*. Together, these components provided us with a system that could be used to design. The next three chapters provide some insight into the use of the digital computer as a design aid, interactive CAD systems, and the software for a CAD system.

An introduction to the functionality incorporated into a General Computer Aided Design System (GCADS) is followed by two chapters that can serve as a mini user's manual for the system. These chapters thus provide the reader with a definitive statement of the generic capability associated with turnkey CAD systems:

- The use of menu system and cursor
- Defining levels of data
- Use of filing systems
- Creation of macros
- Use of editors
- Creation of two- and three-dimensional layouts
- Annotating the drawing
- Plotting
- Material take-offs

The remaining chapters describe such computer graphic functions as windowing, clipping, zooming, rotating, and perspective; the interface of CAD systems to finite element analysis; the application of interactive CAD techniques to machine processes; and the implications of CAD to industry.

The discussion of finite element analysis of CAD is of special interest to those of us in the field of FEM. Besant, in his opening remarks in this section, notes that the finite element method is widely used for the analysis of many engineering programs involving static and dynamic analyses of structures. However, the purported power of the CAD system in supporting the development of the finite element mesh is, in my estimation, overstated. There is no discussion, for example, of the limitations of the geometric model that is used for drafting (wire frame representation) as the basis to the finite element model. As is all too usual, the author's example is a two-dimensional structure for which the CAD data base is more appropriate. The author also glosses over the data generation problems associated with the specification of loads and constraints.

The section on implications of CAD to industry raises some important issues: savings in cost, integration, future technical advances, the trade union's view, and the employer's view. The author notes that the savings in cost are not always apparent, are difficult to assess, and that . . . "Many people who try to assess the cost-effectiveness of CAD tend to concentrate on the use of CAD in drafting which in practice is only a small and specialized application of CAD . . . in mechanical engineering the advantages of using automated drafting systems are often insignificant both in terms of times and cost."

In summary, the author provides us with a good overview of CAD components and the potential for computers in engineering. Unfortunately, this is like trying to drive using only a rearview mirror . . . and a rearward view in the CAD arena is an improbable route toward understanding CAD technology.

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STOCHASTIC STABILITY OF DIFFERENTIAL EQUATIONS

R.Z. Has'minskii
D. Louvigh, transl. and S. Swierczkowski, ed.
Sijthoff and Noordhoff, Amsterdan,
The Netherlands and New York, NY
1980, 344 pp, $50.00

This monograph deals with various mathematical theories of stochastic stability of systems described by differential equations of the general form

$$\dot{\underset{\sim}{x}}(t) = \underline{F}(x, t) + \underline{\sigma}(x, t)\dot{\underset{\sim}{\xi}}(t) \qquad (1)$$

$\underset{\sim}{x}$ is the response vector and $\dot{\underset{\sim}{\xi}}(t)$ is a stochastic process vector. The author emphasizes such mathemmatical aspects of stochastic stability as conditions of bounded and stable solutions in some stochastic sense, identification of systems possessing bounded stochastic response, stationary solutions of nonhomogeneous stochastic differential equations, and conditions of convergence of these solutions.

The book contains eight chapters and is supplemented with one appendix and a bibliography. The first chapter treats the boundness and stability of solutions of the linear form of system (1) in terms of the Liapunov function of the truncated system $\dot{\underset{\sim}{x}} = \underline{F}(x, t)$. The excitation $\dot{\underset{\sim}{\xi}}(t)$ is not specified. A number of stability definitions for the trivial solution $x(t) = 0$ are described.

The second chapter deals with the stationary and periodic processes of solutions of differential equations. These solutions constitute a mathematical idealization of a physical noise acting on linear and nonlinear devices subjected to unvarying or periodically varying properties. The conditions for existence and uniqueness of stationary and periodic solutions of systems whose right hand side is a periodic stationary process are examined. The concepts of ultimate convergence of periodic solutions and stability in the large are outlined. This chapter is concluded with a theory that relates the asymptotically stable differential equations with the periodic solutions of the perturbed system obtained when a small stochastic process is superimposed on a deterministic system.

The theory of differential stochastic equations the solution of wh ch is a Markov process -- i.e., a process that does not depend on the past or a process without aftereffect -- is given in chapter three. Brownian motion (Wiener process) is introduced in order to construct an extensive class of Markov processes with continuous sample functions. The analysis includes conditions under which a Markov process is stationary. The Itô theorems on the existence and properties of solutions of stochastic differential equations are presented without proof. These include the Itô stochastic integral and differential. Conditions for the existence and uniqueness solutions are established. The analysis of the boundary value problem describing the probability density is given in terms of the expectations of certain functionals of the solution of the stochastic differential equations.

The ergodic properties of the solutions are described in chapter four. These include conditions for the existence of a stationary distribution in conjunction with the limit theory of the transition probability for continuous Markov processes in a general Banach space. The behavior of the solutions of the Cauchy problem for partial differential equations of parabolic type is analyzed.

Chapter five establishes the solutions of stability for systems of Itô's equations. These solutions require that the Liapunov function be sufficiently smooth in time and that the process x be in the neighborhood of the origin. This chapter examines the stability in probability -- that the sample path of a process issuing from a point x at a particular time will always remain within any prescribed neighborhood of the origin with probability tending to one as $x \to 0$. The analysis is extended to include other stability modes: asymptotic stability in probability, exponential stability, and almost sure stability.

The applications of these theories to linear stochastic systems is given in chapter six. The differential equations for moments of the response to any order are derived by employing the Itô differential formula. In addition to the study of stability modes described in chapter five, the author introduces uniform stability and stability of products of independent matrices. The analysis is extended to include n-th order linear differential equations with Gaussian white noise coefficients.

Chapter seven treats some problems in the theory of stability of stochastic nonlinear systems. Stability in the first approximation is analyzed on the basis of linearization of nonlinear systems. This chapter shows that the full nonlinear system is always stable whenever the corresponding linearized system has constant coefficients and is almost surely asymptotically stable. The stochastic approximation method (iterative procedure due to Robbins and Monro) that generates conditions for the convergence of a stochastic process is described for single and multi-roots of the regression equation.

The stochastic stability theories are applied to problems of optimal stabilization of controlled systems in chapter eight. The Bellman principle, the optimal Liapunov function for linear control systems, and the method of successive approximation for nonlinear differential equations are among the topics treated in this chapter.

The book contains an appendix and a bibliography. The appendix, which was added in this English edition, is a compilation of some recent results pertaining to the theory of stability of stochastic equations. These results were published after the time of the Russian edition. The bibliography lists 225 references.

The book requires the reader to be acquainted with a high level of probability theory, stochastic and advanced calculus, and the theory of Markov processes. The material in the book is presented in an abstract form and is intended for mathematicians and physicists. Although the theory of stochastic stability has several engineering applications, engineers will have difficulty in following the material presented in this book.

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LOCAL LOADS IN PLATES AND SHELLS

S. Lukasiewicz
Sijthoff and Noordhoff, Amsterdam,
The Netherlands and New York, NY
1979, 580 pp, $85.00

This book covers a vast amount of material on the local loading of plates and shells, including uniform

loading on plates and partial loading on shells. The author, who has been active in this field for many years, has abstracted material from a number of his papers and those of others. A large reference list appears at the end of each chapter.

A preliminary section contains an excellent table of nomenclature. The remainder of the book consists of 14 chapters, each divided into a number of sections.

Chapter 1 describes the basic equations of the theory of plates and shells. The author uses partial derivative notation to obtain the equations of equilibrium, explains the simplified and classical theory of shells, uses tangential and transverse loads on the plate, and briefly summarizes thermal stresses and sandwich and orthotropic shells. The reviewer would have preferred a section on layered plates and a larger section on thermal stresses.

Chapter 2 describes the basic differential equations of isotropic plates, strain energy, and variational equations of isotropic plate theory. Also included is a short section on the sandwich plate.

Chapter 3 considers plates under lateral loads at an interior point. Fourier series and Fourier integrals are applied to circular plates; Fourier integrals are rarely used in plate theory, but the author also applies them to infinite, semi-infinite, and wedge-shaped plates. With regard to thick circular plates, equations of the theory of elasticity are explained. Bending moments via rigid inserts and Green's functions are considered. The reviewer believes that the section on Green's functions should have been expanded.

Chapter 4 treats concentrated lateral loads at the edge of the plate, including the concentrated load on a cantilever plate, concentrated moment on the free edge of a semi-infinite isotropic plate, and concentrated forces on a semi-infinite plate on an elastic foundation. Chapter 5 has to do with loads applied on the middle plane of a circular plate, infinite isotropic and orthotropic plates, and concentrated loads at the edges of rectangular and wedge-shaped plates.

The author discusses large elastic deflections of rectangular and circular plates and the stability of plates. The reviewer considers the section on stability too short.

Chapter 7 is concerned with membrane shells under concentrated loads, including shells of revolution -- spherical and conical shells. The section on conical shells lacks depth. Chapter 8 describes spherical shells loaded by concentrated normal and tangential forces and having concentrated and twisting moments. The concluding section on the effect of boundary conditions is excellent.

Chapter 9 treats the loading of an arbitrary shell by concentrated force. Information on deflection and stress functions and stresses on shells in both Cartesian and polar coordinates is included, as are analyses of load distribution over a small surface and divisions of loads as well as solutions for local loads on an arbitrary shell. An interesting section provides details of an experimental investigation of a shell of revolution that is built in at one edge and free on the second one. Experimental evidence is in good agreement with analytical results.

Chapter 10 focuses on cylindrical and nearly cylindrical shells subjected to a normal force. Equations for cylindrical shells are derived and simplified to shallow cylindrical shells including singularities. An interesting section on a local hot spot does not adequately cover thermal stress. The author describes the effects of boundary conditions on shells with simply supported edges and free edges and concludes with the cylindrically orthotropic shell. This excellent chapter lacks on explanation on the theory of the stability of cylindrical shells.

The chapter on shells under various concentrated loads treats shells loaded by concentrated bending moments and forces and moments that are very large in the vicinity of singular points. The author reduces the complexity of the problem and makes it amenable to engineering applications.

Chapter 12 discusses shells loaded at the free edge by lateral force and local loads. This short chapter concludes with shells loaded by a force normal and tangential to the middle surface and with a concentrated bending moment at its edge. The solutions are completed via Fourier series (Paul Seide and Donnell's solutions). The next chapter has to do with large deflections of spherical and arbitrary shells of positive curvation.

The last chapter on the design of plates and shells under concentrated loads was of special interest to the reviewer. Included are sections on bars of variable cross section, bars of finite length joined to an infinite plate, and a bar of variable rigidity with a concentrated force acting on its middle plane. The chapter also describes elastic and plastic design of plates, minimum weight design, and the design of circular plates under lateral loads (plastic design and concentrated lateral force). The last section is concerned with the design of shells subjected to concentrated force and pressure and with a shell carrying its own weight.

This is an excellent book. The reviewer feels that more numerical examples showing applications of the analytical findings would be of great help. Other additions could be applications of finite differences and finite elements applied to plates and a section on twisted plates. Twisted plates are extremely important in the actions of compressor and turbine blades subjected to vibrating loads. The reviewer recommends this book to individuals interested in the theory and design of plates and shells.

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SHORT COURSES

JUNE

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: June 6-10, 1983
Place: Santa Barbara, California
Dates: August 22-26, 1983
Place: Santa Barbara, California
Dates: October 24-28, 1983
Place: Boulder, Colorado
Dates: November 14-18, 1983
Place: Cincinnati, Ohio
Dates: December 5-9, 1983
Place: Santa Barbara, California

Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (805) 682-7171.

MECHANICS OF HEAVY-DUTY TRUCKS AND TRUCK COMBINATIONS

Dates: June 13-17, 1983
Place: Ann Arbor, Michigan

Objective: This course describes the physics of heavy-truck components in terms of how these components determine the braking, steering, and riding performance of the total vehicle. Covers analytical methods, parameter measurement procedures, and test procedures, useful for performance analysis, prediction and design.

Contact: Continuing Engineering Education, 300 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

MACHINERY VIBRATION ANALYSIS

Dates: June 14-17, 1983
Place: Nashville, Tennessee
Dates: August 16-19, 1983
Place: New Orleans, Louisiana
Dates: November 15-18, 1983
Place: Chicago, Illinos

Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques wll be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation, and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

VIBRATION DAMPING

Dates: June 19-22, 1983
Place: Dayton, Ohio

Objective: The utilization of the vibration damping properties of viscoelastic materials to reduce structural vibration and noise has become well developed and successfully demonstrated in recent years. The course is intended to give the participant an understanding of the principles of vibration damping necessary for the successful application of this technology. Topics included are: damping fundamentals, damping behavior of materials, response

measurements of damped systems, layered damping treatments, tuned dampers, finite element techniques, case histories, and problem solving sessions.

Contact: Michael L. Drake, Kettering Laboratory 104, 300 College Park Avenue, Dayton, OH 45469 - (513) 229-2644.

OCTOBER

UNDERWATER ACOUSTICS AND SIGNAL PROCESSING

Dates: October 3-7, 1983

Place: State College, Pennsylvania

Objective: This course is designed to provide a broad, comprehensive introduction to important topics in underwater acoustics and signal processing. The primary goal is to give participants a practical understanding of fundamental concepts, along with an appreciation of current research and development activities. Included among the topics offered in this course are: an introduction to acoustics and sonar concepts, transducers and arrays, and turbulent and cavitation noise; an extensive overview of sound propagation modeling and measurement techniques; a physical description of the environment factors affecting deep and shallow water acoustics; a practical guide to sonar electronics; and a tutorial review of analog and digital signal processing techniques and active echo location developments.

Contact: Alan D. Stuart, Course Chairman, Applied Research Laboratory, The Pennsylvania State University, P.O. Box 30, State College, PA 16801 - (814) 865-7505.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

JOHN C. SNOWDON VIBRATION CONTROL SEMINAR
October 31 - November 4, 1983
Pennsylvania State University

The Pennsylvania State University will offer another one of its Vibration Control seminars on October 31 - November 4, 1983, again under sponsorship of the Applied Research Laboratory. These seminars, which are presented by internationally known lecturers, were initiated by the late Professor John C. Snowdon a decade ago and now continue under the guidance of Dr. Eric E. Ungar of Bolt Beranek and Newman, Inc. The seminars emphasize principles, general approaches and new developments, with the aim of providing participants with efficient tools for dealing with their own practical vibration problems.

For further information contact: Mary Ann Solic, 410 Keller Conference Center, University Park, Pennsylvania 16802 - (814) 865-4591 (TWX No: 510-670-3532).

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of publications abstracted are not available from SVIC or the Vibration Institute, except those generated by either organization. Government Reports (AD-, PB-, or N-numbers) can be obtained from NTIS, Springfield, Virginia 22151; Dissertations (DA-) from University Microfilms, 313 N. Fir St., Ann Arbor, Michigan 48106; U.S. Patents from the Commissioner of Patents, Washington, DC 20231; Chinese publications (CSTA-) in Chinese or English translation from International Information Service Ltd., P.O. Box 24683, ABD Post Office, Hong Kong. In all cases the appropriate code number should be cited. All other inquiries should be directed to libraries. The address of only the first author is listed in the citation. The list of periodicals scanned is published in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 962, 1082)

83-874

Unstable Vibrations of an Unsymmetrical Shaft at the Secondary Critical Speed Due to Ball Bearings

T. Yamamoto, Y. Ishida, et al.

Nagoya Univ. [illegible]

Bull. JSME, 25 [illegible]

7 figs, 10 refs

Key Words: Shafts, Variable material properties, Asymmetry, Ball bearings, Vibration response

It is clarified theoretically and experimentally that when an unsymmetrical shaft is supported by single-row deep groove ball bearings, an unstable vibration with frequency $+2\omega$ (ω rotating speed of a shaft) appears at the secondary critical speed due to the coexistence of a stationary directional difference and a rotating directional difference of stiffness. The stationary directional difference is due to the directional difference of support condition by means of a single-row deep groove ball bearing which has angular clearance, and the rotating directional difference is due to the flatness of the shaft.

83-875

Nonlinear Forced Oscillations of a Rotating Shaft Carrying an Unsymmetrical Rotor at the Major Critical Speed

T. Yamamoto, Y. Ishida, T. Ikeda, and M. Yamamoto

Nagoya Univ., Chikusa-ku, Nagoya, Japan, Bull. JSME, 25 (210), pp 1969-1976 (Dec 1982) 11 figs, 12 refs

Key Words: Shafts, Asymmetric excitation, Critical speeds, Forced vibration

This paper deals with the motion of an unsymmetrical rotor possessing nonlinear spring characteristics due to the angular clearance of a single-row deep groove ball bearing in the vicinity of the major critical speed. When this system is operated near the major critical speed, no unstable vibration occurs, but peculiar resonance curves of hard spring type are obtained which have three stable amplitudes at most against the rotating speed.

83-876

The Condition that a Rigid Rotor in Two Elastic Supports Can Pass through Resonance

A. Fedzun, A. Zobnin, and I. Neigebauer

[illegible] 1 (39), pp 65-74 (1981) 1 fig, 5 refs

Key Words: Rotors, Resonance pass through, Elastic foundations

The rotor in two elastic supports accelerated through resonance is considered. It is possible to make an expression for its passing through resonance. Experimental data and calculated conditions are presented for two real rotors.

83-877

Natural Frequencies of a Shaft with Periodically Placed Rotors and Bearings

S.K. Patnaik and A.K. Mallik

Dept. of Mech. Engrg., Indian Inst. of Tech., Kanpur-208016, India, J. Sound Vib., 85 (3), pp 415-422 (Dec 8, 1982) 7 figs, 1 table, 13 refs

Key Words: Shafts, Natural frequencies, Flexural vibration, Torsional vibration

Flexural and torsional natural frequencies of a shaft with periodically placed rotors and bearings are investigated by using a wave approach. By a judicious choice of parameters it is possible to obtain ranges of operating speed that are free from both flexural and torsional resonances. Suggestions for widening such speed ranges are included.

83-878

Non-Linear Effect in High Speed Rotor Noise

J.D. Morgan

Dept. of Mathematical Sciences, Univ. of Dundee, Dundee DD1 4HN, UK, J. Sound Vib., 85 (4), pp 501-511 (Dec 22, 1982) 9 refs

Key Words: Rotors, Helicopter noise, Sound propagation, Aerodynamic loads

The noise radiated by a high speed rotor is strongly influenced by nonlinear air flows near the tip. These nonlinearities are made susceptible to analysis by first approximating the full equation by one in which the most significant nonlinear term is retained. A certain change of variables then transforms this into the linear acoustic equation with all the simplification this implies.

83-879
On the Damping Effect of Sloshing Fluid on Flexible Rotor Systems

M.K. Ghosh, P.C. Upadhyaya, and A. Kumar
Banaras Hindu Univ., Varanasi, India, ASME Paper No. 82-DET-140

Key Words: Rotors, Elastic foundations, Fluid-filled containers, Sloshing, Fluid-induced excitation, Damping effects, Vibration control

Results of an experimental investigation on the vibration attenuation characteristics of a free liquid sloshing in a rigid container are reported for a flexible rotor on a flexible foundation. Attenuation of the vibrational amplitude of the foundation is markedly seen in the experimental results.

83-880
Unbalance Behavior of Squeeze Film Damped Multi-Mass Flexible Rotor Bearing Systems

L.J. McLean and E.J. Hahn
Univ. of New South Wales, Kensington, NSW, Australia, J. Lubric. Tech., Trans. ASME, 105 (1), pp 22-28 (Jan 1983) 4 figs, 14 refs

Key Words: Rotors, Unbalanced mass response, Squeeze film dampers

A solution technique is developed whereby the problem of determining the synchronous unbalance response of general multi-degree of freedom rotor bearing systems is reduced to solving a set of as many simultaneous nonlinear equations in damper orbit eccentricities as there are dampers. It is shown how, in the case of a single damper, the resulting nonlinear equation may be solved directly to determine all possible orbit eccentricity solutions as a function of the rotor speed and bearing parameter, thereby ensuring completeness of solution, eliminating convergence problems and clearly indicating all multistable operation possibilities.

83-881
Effect of Biphase Lubricants on Dynamics of Rigid Rotors

A. Mukherjee
Dept. of Mech. Engrg., I.I.T., Kharagpur, India, J. Lubric. Tech., Trans. ASME, 105 (1), pp 29-38 (Jan 1983) 24 figs, 11 refs

Key Words: Rotors, Rigid rotors, Unbalanced mass response, Whirling, Lubrication

The dynamic behavior of rigid rotors as affected by the use of liquid-solid biphase lubricants in the supporting hydrodynamic bearings is studied theoretically. Two categories of dynamic behavior – unbalance response at low rotor speeds and half frequency whirl at high speeds – are studied. It is shown that the use of liquid-solid biphase lubricants causes considerable reduction in the size of journal orbit of an unbalanced rotor. The influence of particle size and dispersion concentration is studied.

83-882
A Study of the Lubricant Film Characteristics of Journal Bearings (Part 3, Effects of the Film Viscosity Variation on the Dynamic Characteristics of Journal Bearings)

J. Mitsui
Tamano Lab., Mitsui Engineering and Shipbuilding Co., Ltd., 1-1, Tama 3-Chome, Tamano, Okayama Pref., Japan, Bull. JSME, 25 (210), pp 2018-2029 (Dec 1982) 14 figs, 6 refs

Key Words: Rotors, Bearings, Journal bearings, Oil film, Viscosity effects, Spring constants, Damping coefficients

It is becoming increasingly important to determine the dynamic characteristics of journal bearings precisely for high speed rotating machines. In this paper the oil film spring and damping coefficients are calculated taking into consideration the effect of oil film viscosity variation. The theoretical results make clear the influences of the journal speed and bearing clearance ratio on these coefficients.

83-883
Magnetic Vibration of Large Turbo-Generator Stators and Its Suppression

Mao-hong Yu, Mei-feng Le, Guang-hao Wu, Ya-sheng Shao, and De-shu Huang

Xi'an Jiaotong Univ., Acta Mech. Solida Sinica, Chinese Soc. Theo. Appl. Mech., (3), pp 425-436 (Aug 1982) 12 figs, 2 tables, 7 refs

Key Words: Turbogenerators, Magnetoelastic vibrations, Vibration control

The magnetic vibration problems of a large turbo-generator and the methods used for the suppression of the severe vibration are described. Using the energy method, the finite element method and the structural model analysis, an analysis is made of the natural frequency, mode shapes, dynamic response of generator stator frames and all the factors that affect the vibration characteristics of generator stators, such as stiffening ribs, strengthening in the corner of the frame, welding length, stiffness of foundation and vibration-suppressor band.

83-884

Wind Tunnel Measurements of Blade/Vane Ratio and Spacing Effects on Fan Noise

R.P. Woodward and F.W. Glaser

NASA Lewis Res. Ctr., Cleveland, OH, J. Aircraft, 20 (1), pp 58-65 (Jan 1983) 19 figs, 1 table, 27 refs

Key Words: Fans, Fan noise, Aircraft noise, Aircraft engines, Engine noise, Wind tunnel testing

A research fan stage was acoustically tested in an anechoic wind tunnel with a 41-m/s tunnel flow. Two stator vane numbers, giving cuton and cutoff conditions were tested at three rotor-stator spacings ranging from about 0.5 to 2.0 rotor chords. These two stators were designed for similar aerodynamic performance. The cutoff criterion strongly controlled the fundamental tone level at all spacings.

83-885

Dynamic Response of Two Speed ID Fan Operation

J.G. Nelson and J.S. Bowes

Gilbert/Commonwealth, Jackson, MI, ASME Paper No. 82-JPGC-Pwr-51

Key Words: Fans, Heat generation, Dynamic response, Computer-aided techniques

This paper examines furnace and gas path pressure and flow transients during ID fan speed changes by using dynamic computer model of the air/furnace/gas path, fans and draft control systems. Presented are time transients of furnace drafts following speed changes.

83-886

Asymmetrical Torsional Vibrations in the Symmetric Engine

Bo Zhong Li, et al

Chinese Internal Combustion Engine Engrg., 3 (2), pp 8-17 (1982)

CSTA No. 621.43-82.28

Key Words: Engine vibration, Asymmetric excitation, Torsional vibration

In this paper the question of auxiliary-drive tapped at the fly-wheel end is analyzed. Effects due to disturbances from the main system are examined to interpret some of the test results given earlier.

RECIPROCATING MACHINES

(See Nos. 1029, 1084)

POWER TRANSMISSION SYSTEMS

(See No. 1077)

METAL WORKING AND FORMING

83-887

Research on Movement Stability in Sliding Parts of Machine Tool

Zhong Yong Gao, et al

Machine Tool and Hydraulics, 2, pp 22-34 (1982)

CSTA No. 621.8-82.02

Key Words: Machine tools, Stability

Sliding parts in various driving speed conditions are analyzed. The factors of inherent influence are discovered. A comprehensive critical criterion suitable for movement stability of sliding parts in various speed conditions is given.

83-888

Dynamic Response and Optimal Design of a Lathe Spindle under Experimentally Measured Random Cutting Force Excitations

A.M. Sharan

Ph.D. Thesis, Concordia Univ., Canada (1982)

Key Words: Lathes, Dynamic response, Optimum design, Cutting, Random excitation

This thesis presents the dynamic response and optimal design of a lathe spindle under experimentally measured random cutting force excitations. The optimal design is based on minimizing the maximum mean square displacement response of the workpiece under the action of random cutting forces. The stochastic partial differential equation of motion characterizing the behavior of a lathe spindle-workpiece system is formulated based on the Euler-Bernoulli equation. A finite element method using beam elements is used for free vibration analysis to compute the undamped mode shapes and the natural frequencies of the spindle-workpiece system.

MATERIALS HANDLING EQUIPMENT

83-889
Determination of Load in a Driving System (Bestimmung der Belastung in einem Antriebssystem)
G. Lindemann
VEB Kombinat Getriebe und Kupplungen Magdeburg, German Dem. Rep., Maschinenbautechnik, 31 (12), pp 559-560, 564 (1982) 6 figs, 3 refs
(In German)

Key Words: Hoists, Cranes (hoists), Mechanical drives, Dynamic structural analysis

A method for determination of load in a crane drive during starting and braking operations is described. The dynamic characteristic of a hoisting unit is essentially determined by the coupling between motor and gearing. Its influence and load are calculated.

83-890
Vibrating Separator
D.H. Lenker and D.F. Nascimento
Dept. of Agriculture, Washington, DC, U.S. Patent Appl. No. 6-290 540, 17 pp (Aug 1981)

Key Words: Belt conveyors, Vibrators (machinery), Materials handling equipment

An apparatus for separating objects of different shapes or sizes is described. A vibrating conveyor belt is equipped with upwardly projecting fingers spaced at intervals to entrap therein objects of a particular size or shape and convey them in the direction of the movement of the belt and to simultaneously support objects of another shape or size on the ends of the fingers and to convey them by vibration in a direction different from the movement of the belt, thereby separating the objects.

STRUCTURAL SYSTEMS

BRIDGES
(Also see No. 1049)

83-891
Investigation of Wind-Induced Vibration of Cable-Stayed Bridge and Its Wind Tunnel Test
Haifan Xiang, et al
China Civ. Engrg. J., 15 (1), pp 1-13 (1982)
CSTA No. 624-82.15

Key Words: Bridges, Cable-stayed bridges, Wind-induced excitation, Wind tunnel testing

A study of the wind-induced vibration of a cable-stayed bridge is presented together with its sectional model tunnel test. The test result agrees with the calculated by the two-dimensional flutter theory.

BUILDINGS
(Also see No. 980)

83-892
Deterministic Seismic Design Procedures for Reinforced Concrete Buildings
T. Paulay
Dept. of Civil Engrg., Univ. of Canterbury, Christchurch, New Zealand, Engrg. Struc., 5 (1), pp 79-86 (Jan 1983) 7 figs, 8 refs

Key Words: Buildings, Reinforced concrete, Seismic design

A brief review is given of a deterministic design philosophy with respect to earthquake resisting ductile structures for reinforced concrete buildings. In this approach a preferred hierarchy in the development of energy dissipating mechanisms is postulated. Some applications of capacity design procedures relevant to beams, columns and shear walls, are

outlined. The paramount importance of quantifiable good detailing is emphasized and the relevance of this with respect to shear effects in plastic hinges, the confinement of compressed concrete, and bond between reinforcement and concrete are examined.

83-893
Control of Tall Buildings in Along-Wind Motion

J.N. Yang and B. Samali
Dept. of Civil, Mech., and Environmental Engrg., The George Washington Univ., Washington, DC 20052, ASCE J. Struc. Engrg., 109 (1), pp 50-68 (Jan 1983) 5 figs, 1 table, 33 refs

Key Words: Buildings, Wind-induced excitation, Active vibration control

An exploratory study is made of the possible application of active control systems to tall buildings in along-wind motion. An analytical procedure is developed to compute the statistical properties of the structural response of a tall building implemented by an active control system and excited by a random wind flow which is stationary in time and nonhomogeneous in space. The problem is formulated in terms of transfer matrices and the random vibration analysis is carried out.

83-894
Wind Pressures on Low Buildings with Parapets

T. Stathopoulos
Centre for Bldg. Studies, Concordia Univ., Montreal, Quebec, Canada, ASCE J. Struc. Engrg., 108 (ST12), pp 2723-2735 (Dec 1982) 10 figs, 1 table, 10 refs

Key Words: Buildings, Wind-induced excitation, Wind tunnel testing, Experimental test data

This paper presents the results of a recent experimental study carried out in a boundary layer wind tunnel in order to determine the wind loads on low-rise buildings of different configurations with and without parapets.

83-895
Statistical Analysis of Design Load Coefficient for Multi-Story Brick Buildings Against Seismic Cracking and Collapsing

Yucheng Yang and Liu Yang
China Civ. Engrg. J., 15 (1), pp 14-26 (1982)
CSTA No. 624-82.16

Key Words: Buildings, Seismic design, Statistical analysis

Damages of multi-story brick buildings during earthquakes are correlated in this paper with the inherent earthquake resistant capacity (earthquake resistant strength coefficient) of the structures by means of statistical analysis. The design load coefficient for rigid multi-story brick buildings against seismic cracking or collapsing is obtained along with the design aseismic reliability of multi-story brick buildings.

83-896
The Effect of Duration of Strong Ground Motion on the Collapse of Structures

Zhi Xin Xu and Da Gen Weng
J. of Tung-Chi Univ., 2, pp 7-24 (1982)
CSTA No. 624-82.51

Key Words: Buildings, Earthquake damage, Ground motion

The stiffness degrading single degree-of-freedom system, which is the mathematical model of a class of structures taking P-δ effort into consideration under the excitation of 41 accelerograms in the USA and 12 accelerograms in China, has been investigated for collapse. The minimum intensities of excitation causing collapse for structures with various parameters are calculated.

TOWERS

83-897
Vibration Analysis of Three Guyed Tower Designs for Intermediate Size Wind Turbines

R.J. Christie
Tanksley (W.L.) and Associates, Inc., Brook Park, OH, Rept. No. DOE/NASA/1900-1, NASA-CR-165589, 113 pp (Mar 1982)
N82-30709

Key Words: Towers, Guyed structures, Wind turbines, Natural frequencies

Three guyed tower designs are analyzed for intermediate size wind turbines. The four lowest natural frequencies of vibration of the three towers concepts are estimated. A parametric study is performed on each tower to determine

the effect of varying such tower properties as the inertia and stiffness of the tower and guys, the inertia values of the nacelle and rotor, andthe rotational speed of the rotor.

83-898
Tower Dynamics Analytical Models: Comparison and Evaluation

A.D. Wright
Rocky Flats Plant, Atomics Intl. Div., Golden, CO, Rept. No. RFP-3340, 165 pp (Dec 1981)
DE82015602

Key Words: Towers, Guyed structures, Rayleigh-Ritz method, Finite element technique, Matrix methods, Iteration, Computer programs, Experimental test data

Several simple tower dynamic analysis methods and computer codes are described and evaluated by comparison with tower test results. The theory of these methods is described. The Rayleigh and Rayleigh-Ritz methods, finite element method, and matrix iteration method are presented. Four different towers are described, to show the correct data input for the methods. The test methods and test results for each tower are given and results for two freestanding and two guyed towers shown.

FOUNDATIONS

(Also see No. 912)

83-899
Behavior of Anisotropic Clays Subjected to Cyclic Loading

T.A.A. Macky
Ph.D. Thesis, Case Western Reserve Univ., 298 pp (1982)
DA8224664

Key Words: Soils, Clays, Cyclic loading, Experimental test data

This study is experimental in nature. Its purpose is to study the dynamic behavior of both artificially prepared and naturally deposited clays. Hollow cylindrical specimens were used to evaluate the moduli and the damping under cyclic axial and shear loadings; or a combination of both. Two types of laboratory devices were used to determine the static and dynamic properties. A specially designed resonant column applying fast cyclic loading was used to determine the dynamic response at relatively small strains, and a specially designed triaxial cell with a pneumatic analog computer (SPAC) applying static and slow cyclic loading were used to study the behavior at relatively large strains.

83-900
Methods of Finding Natural Frequencies of a Foundation under Coupled Vibration with Iteration Procedure and Determining Parameters of the Foundation with Amplitude Responses

Shun Yong Lu and Zhen Dong Zhao
J. of Building Structure, 3 (3), pp 73-80 (1982)
CSTA No. 624-82.31

Key Words: Foundations, Coupled response, Natural frequencies, Iteration

The first part of this paper presents an iteration method for finding the natural frequencies of a foundation under coupled vibration. The operation of the iteration is simple and convergent rapidly for general damped vibration problems and appropriate to engineering use. In the second part a method has been proposed to determine the parameters of the foundation mentioned above with its amplitude responses of displacement at corners, so that the phase measurements can be avoided.

83-901
A Graphical Solution for Foundation Natural Frequencies

J.P. Moore
Centennial Engrg., Arvada, CO, Plant Engrg., pp 93-94 (Jan 20, 1983) 2 figs

Key Words: Natural frequencies, Foundations, Equipment mounts, Graphic methods

Foundations for vibrating equipment must be designed not only to satisfy static load requirements but also to prevent resonance between the equipment and the foundation. This article presents a graphical design aid for readily obtaining the foundation frequency in terms of the bearing pressure for a range of values of the foundation modulus.

83-902
Analysis of Permanent Displacement from Cyclic Loading of Foundations

A.M. Urzua and W.A. Marr

Sea Grant College Program, Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. MITSG-81-9, NOAA-82080609, 346 pp (July 1982)
PB83-113753

Key Words: Foundations, Cyclic loading, Computer programs, Finite element technique

A linear viscoelastic formulation with parameters from stress path type tests promises a rational means to predict permanent displacements from drained cyclic loading with sufficient accuracy for most practical purposes. The finite element program, CYPEDE, gives an analytical procedure to calculate these permanent displacements.

83-903

Stochastic Earthquake Response of Structures on Sliding Foundation

G. Ahmadi
Dept. of Mech. and Industrial Engrg., Clarkson College, Potsdam, NY 13676, Intl. J. Engrg. Sci., 21 (2), pp 93-102 (1983) 5 figs, 1 table, 48 refs

Key Words: Foundations, Seismic design, Coulomb friction, Stochastic processes

Stochastic earthquake response of structures on sliding foundation is studied. The structure is modeled by a rigid mass and Coulomb friction is considered between the structure and its foundation. A nonstationary white noise model of earthquake ground motion is employed and the response of the system is investigated by the generalized method of equivalent linearization. The results are compared with those of the stationary analysis and some estimates for the maximum slip are obtained and discussed.

83-904

Determination of Static Bearing Capacity of Single Pile by Wave Equation Using Input of Direct Force Wave Measurement

Shouxin Liang, et al
J. Bldg. Structure, 3 (2), pp 68-78 (1982)
CSTA No. 624-82.14

Key Words: Pile structures, Pile driving, Wave equation

A wave equation analysis using input of direct force wave measurement with the conception of isolated body is presented and a computer program is developed. Nine parameters in relation to hammer are eliminated, so that the reliability of the wave equation analysis is increased. The experimental results of ten precast square piles with static and dynamic measurements show that the ultimate bearing capacity of single piles obtained by the above mentioned method is in good agreement with that obtained from static measurement in field.

83-905

The Development of a Nonlinear Soil Element Using a Modified Endochronic Material Model

R.F. Oleck, Jr.
Ph.D. Thesis, Syracuse Univ., 114 pp (1982)
DA8229007

Key Words: Nuclear power plants, Interaction: soil-structure, Seismic analysis, Nonlinear theories, Computer programs

There are many available nonlinear soil material models, but they are complex and cannot properly predict the stress strain relationship under irregular loadings such as earthquakes. The simple endochronic theory has been modified to properly model stress-strain behavior under irregular loadings and a computer subroutine called ENDO has been developed for a two-dimensional, quadrilateral element. The subroutine has been included within a standard finite element program, SAP7. Parametric studies using linear regression analysis resulted in specific recommendations for input parameters making utilization simple. Required parameters are related to strain levels, confining pressure and relative density.

83-906

Numerical Analysis of Framed Structure-Foundation-Soil Interaction, with Linear and Non-linear Soil Behavior Models

Bai li Zhu, et al
J. Tung-Chi Univ., 4, pp 15-31 (1981)
CSTA No. 624.81 99

Key Words: Interaction. soil-structure

In this paper detailed studies of the mechanism of framed structure-foundation-soil interaction, as well as analyses of multi-storied, multi-span structures are given and comparisons are made with previous investigations. For the nonlinear stress-strain analysis, the hyperbolic stress-strain relationship of Duncan-Chang model is chosen.

83-907

A Method for Earthquake Analysis of Soil-Structure Interaction Problem

Chang Sheng Fu and Zai Dao Yu
J. of Tung-Chi Univ., 1, pp 1-13 (1982)
CSTA No. 624-82.33

Key Words: Interaction: soil-structure, Substructuring methods, Earthquake response

The advantages and disadvantages of the mass-spring system and FEM are briefly described in analyzing the soil-structure interaction problem. A modified substructure method is developed on the basis of the general substructure method, taking into account the relative displacements on both sides of the interface. The assumption that the foundation is welded to the ground is no longer necessary using this method.

UNDERGROUND STRUCTURES

83-908

Investigation of the Natural Frequency for Shallow-Buried Underground Structure

Guo Hao Li, et al
J. of Tung-Chi Univ., 2, pp 1-6 (1982)
CSTA No. 624-82.50

Key Words: Underground structures, Natural frequencies

The natural frequency of a top slab (simplified as a simply-supported beam) of an underground structure is studied by theoretical analysis and model tests.

HARBORS AND DAMS

83-909

To Study the Dynamic Characteristics of Hydraulic Structures by a Holographic Interferometric Method

Po Qin Lee and Xing Yuan Shen
J. Hydraulic Engrg., 3, pp 23-34 (1982)
CSTA No. 627-82.19

Key Words: Dams, Hydraulic systems, Holographic techniques, Interferometric techniques

A general holographic interferometry for determining dynamic characteristics of hydraulic structures is presented. Based on the theory of holographic interferometry, experimental arrangement for obtaining the frequency of vibration and three-dimensional amplitude is demonstrated. A method for determining the frequency of the structure is described and an effective analysis method of vibration stress using the data of three-dimensional amplitude by the technique of holographic interferometry is given.

POWER PLANTS

(Also see Nos. 905, 999)

83-910

A Solution of the Vibrational Response of Reactor Components to Random Exciting Forces Due to Coolant Flow

V. Kuzelka
National Res. Inst. for Machine Design, SVUSS, 250 97 Prague 9 - Bechovice, Czechoslovakia, Nucl. Engrg. Des., 72 (2), pp 189-196 (Sept 11, 1982) 12 figs, 6 refs

Key Words: Nuclear reactor components, Random excitation

The derivation and computer implementation of the mathematical model for a numerical solution of the reactor component responses to the effects of random forces induced by the turbulence of the coolant flow is presented. The computer implementation of the model, applied to cohesive fuel bundles, is demonstrated in the system with eight degrees of freedom. The code ODEZ 1 is developed and numerical results are compared with experimental ones.

OFF-SHORE STRUCTURES

83-911

Dynamic Anaysis of Tension-Leg Platforms

J.R. Morgan and D. Malaeb
Univ. of Houston, Houston, TX, Rept. No. NSF/CEE-82033, 132 pp (Jan 1982)
PB83-100982

Key Words: Off-shore structures, Drilling platforms, Time domain method

A deterministic approach for the dynamic analysis of tension-leg platforms subjected to wave forces and ground motion is described. A mathematical model is developed based on a set of coupled nonlinear differential equations for sway,

surge, heave, pitch, roll, and yaw motions. A time domain analysis is selected for investigating the dynamic characteristics of the anchored structure.

83-912
Aspects of Soil-Structure-Water Interaction Problems

G.D. Stefanou
Chair of Concrete Structures, School of Engrg., Univ. of Patras, Patras, Greece, Computers Struc., 16 (5), pp 629-638 (1983) 20 figs, 2 tables, 16 refs

Key Words: Interaction: soil-structure, Underwater structures, Earthquakes, Seismic analysis

The application of numerical methods, the finite element, the finite difference and dynamic relaxation, for the solution of problems in soil-structure interaction is considered. Some results of center line stresses, contact and radial stresses are given for a plate of variable stiffness resting on a non-homogeneous elastic half-space. Recent developments on the analysis of foundations, joints and fluid systems are discussed. The development of a fluid element for the analysis of fluid-solid systems and a new free-field element for earthquake analysis is presented. The introduction of relative displacements in the equilibrium equations of interface elements is also described.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see No. 937)

83-913
The Yaw Stability of Tractor-Semitrailer During Steady-State Cornering

F. Vlk
High Technical College, Brno, Czechoslovakia, Strojnicky Casopis, 33 (6), pp 729-743 (1982) 12 figs, 10 refs
(In Czech)

Key Words: Articulated vehicles, Cornering effects

This paper is concerned with the stability of motion of a tractor-semitrailer during steady-state cornering using a linear mathematical model. The method described enables clear and obvious determination, the design parameters having a decisive influence on handling of a tractor-semitrailer during steady-state cornering.

83-914
Spectral Analysis of Freight Car Truck Lateral Response

L.M. Sweet and A. Karmel
Dept. of Mech. and Aerospace Engrg., Princeton Univ., Princeton, NJ 08544, J. Dynam. Syst., Meas. Control, Trans. ASME, 104 (4), pp 297-304 (Dec 1982) 15 figs, 15 refs

Key Words: Freight cars, Railroad cars, Lateral response, Interaction: rail-vehicle, Spectrum analysis

Methods used to quantify the lateral response of freight car trucks to random track irregularity inputs are summarized. Spectral analysis is applied to the results of an extensive series of experiments using a one-fifth scale model of a truck and half carbody, in which all inertial, friction, creep, and stiffness forces are dynamically scaled. The repeatability and confidence limits for estimates of the spectral densities of track inputs and truck response variables are determined. The influence of forward velocity, truck internal friction, and axle load on the dominant truck response modes is presented.

83-915
Vibration Testing of Railroad Tank Car Specimens

J.E. Harris and W.E. Pierce
National Space Tech. Labs., NSTL Station, MS, Rept. No. DOT/FRA/ORD-82/28, 61 pp (May 1982)
PB83-105023

Key Words: Tank cars, Railroad cars, Walls, Coatings, Vibration tests

Vibration tests of fireproof coatings were performed on test specimens measuring 4 feet square. Specimens were simulations of railroad tank car sidewall panels. Samples of fireproof coatings from three different manufacturers were tested. The vibration test consisted of application of a prescribed vibration spectrum perpendicular to the test panels, determination of natural resonances within the test frequency range, and examination of the test specimens for deterioration or failure of the coatings.

83-916

A Shakedown Analysis of Wheel-Rail Contact Stress Problem

Hongyao Wu and Yuren Cheng

J. China Railway Society, 4 (1), pp 76-83 (1982) CSTA No. 625.1-82.08

Key Words: Interaction: rail-wheel, Shakedown theorem

The wheel-rail interaction, in nature, is nothing but a problem of contact stress produced in a body subjected to repeated loads. A rational strength criterion of such a problem can be found only by a shakedown analysis on the theory of plasticity. In this paper, after the introduction of Hertz's elastic solution of wheel-contact stress, a shakedown analysis is made according to Melan's rule and a new criterion for wheel-rail strength design is proposed.

SHIPS

83-917

Forward Speed Effects in the Equations of Ship Motion

L.R. Marshall, A.H. Nayfeh, and D.T. Mook

Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Sound Vib., 85 (3), pp 303-313 (Dec 8, 1982) 1 fig, 1 table, 13 refs

Key Words: Ships, Equations of motion, Energy methods, Damping coefficients

The explicit speed dependency of the coefficients in the linear equations of ship motion is determined from an energy formulation of the problem as opposed to the usual strip-theory formulation. The results of the energy approach are found to agree quite well with the results of three strip-theory formulations regarding the speed dependency of the coefficients in the heave and pitch equations.

AIRCRAFT

(Also see Nos. 932, 1081)

83-918

Propeller Noise at Model- and Full-Scale

W.J.G. Trebble, J. Williams, and R.P. Donnelly

Royal Aircraft Establishment, Farnborough, Hampshire, UK, J. Aircraft, 20 (1), pp 34-41 (Jan 1983) 18 figs, 2 refs

Key Words: Aircraft noise, Propeller noise, Noise measurement, Aerodynamic loads, Dynamic tests, Model testing

Experiments have been completed on a Dowty-Rotol four-bladed R292 propeller at full-scale in a 24-ft anechoic tunnel and at quarter-scale on a geometrically similar model in a 1.5-m acoustic tunnel. Measurements were made of power, torque, and thrust, simultaneously with microphone recording of the propeller noise signal. Analysis of the third-octave and narrow-band spectra are presented for a range of rotational speeds up to a blade-tip Mach number of 0.75, for an extensive range of blade-angle settings, with tunnel airspeeds up to 50 m/s. The relevance of aerodynamic testing at airstream speeds approaching typical flight Mach numbers is illustrated. Parametric formulas and fundamental theoretical frameworks for propeller noise prediction are discussed.

83-919

Cross-Coupling Between Longitudinal and Lateral Aircraft Dynamics in a Spiral Dive

M. Velger and J. Shinar

Technion - Israel Inst. of Tech., Haifa, Israel, J. Aircraft, 20 (1), pp 21-26 (Jan 1983) 9 figs, 19 refs

Key Words: Aircraft, Longitudinal response, Lateral response, Aerodynamic loads

Spiral dive phenomenon, encountered mainly in light, unswept wing, general aviation aircraft, is investigated. The investigation was performed by a nonlinear five-degrees-of-freedom simulation of the aircraft response to elevator deflection during a gliding turn. The simulation results indicate that this phenomenon is generated by an aerodynamic cross-coupling created owing to the dependence of the rolling moment coefficient on the angle of attack. The paper presents the mechanism of the development of the phenomenon, which is composed of three motions at almost separate time scales: a fast longitudinal motion, a slowly divergent lateral motion, and a combined kinematic response of the aircraft.

83-920

Novel Airborne Technique for Aircraft Noise Measurements above the Flight Path

T.A. Holbeche and A.F. Hazell

Royal Aircraft Establishment, Farnborough, Hamp-

shire, UK, J. Aircraft, 20 (1), pp 50-57 (Jan 1983) 12 figs, 9 refs

Key Words: Aircraft, Noise measurement, Inflight testing

Wing-shielding effects for a TriStar airliner in flight have been deduced from a comparison of the engine noise measured simultaneously above and below the flight path; the specialized technique developed for these experiments is described and evaluated. Noise radiated upwards was monitored by flying the aircraft beneath a large instrumented fiberglass sphere suspended from a hovering helicopter; the sphere incorporated a flush mounted pressure microphone and a battery operated telemetry system. Flyover noise at ground level was recorded conventionally.

83-921

Aerodynamic Coefficient Identification of Time-Varying Aircraft System and Its Application

Tong Wang

Acta Aeron. et Astron. Sinica, 3 (1), pp 67-76 (1982) CSTA No. 629.1-82.09

Key Words: Aircraft, Parameter identification technique, Aerodynamic characteristics, Time-dependent parameters

Aerodynamic coefficient identification for a time-varying aircraft system is studied. On the basis of practical measurement in flight tests and by analyzing trend of the coefficients in aircraft time-varying differential equations, it is possible to transform the individual time-varying coefficient into a known function multiplied by an unknown constant. These unknown constants are referred to as undefined coefficients. With the aid of the Newton-Raphson method extended to the time-varying coefficient differential equations the undefined coefficients can be evaluated by iteration calculation. In this way the complicated time-varying aircraft identification can be carried out.

83-922

A New Concept for Aircraft Dynamic Stability Testing

M.E. Beyers

Natl. Res. Council of Canada, Ottawa, Ontario, Canada, J. Aircraft, 20 (1), pp 5-14 (Jan 1983) 7 figs, 2 tables, 9 refs

Key Words: Aircraft, Dynamic tests

A new approach to dynamic stability testing is introduced, based on the concept of orbital fixed-plane motion. An apparatus is conceived with which an aircraft model is forced in an orbital path while constrained to the fixed-plane reference system. An exposition of the concept is given and the potential advantages in captive model testing and applications in flight mechanics are indicated.

83-923

A Model for Predicting Bird and Ice Impact Loads on Structures

L.I. Boehman and A. Challita

Res. Inst., Dayton Univ., Dayton, OH, Rept. No. UDR-TR-79-54, AFWAL-TR-82-2046, 96 pp (May 1982)

AD-A119 408

Key Words: Aircraft, Bird strikes, Computer programs

This report describes a loading model for computation of the pressure distribution exerted on surfaces during bird and ice impacts. Bird and ice impacts are considered as fluid dynamic in nature and are modeled as fluid jets impinging on arbitrarily shaped three dimensional deformable surfaces. A quasi-steady, potential flow analysis is applied to the jet impact problem thereby reducing the impact problem to the problem of solving Laplace's equation. The surface singularity technique is used to solve Laplace's equation. A computer program for computing pressure distributions on both rotating and non-rotating turbine engine components is described.

83-924

Noise of a Model Helicopter Rotor Due to Ingestion of Isotropic Turbulence

R.W. Paterson and R.K. Amiet

United Technologies Res. Ctr., East Hartford, CT 06108, J. Sound Vib., 85 (4), pp 551-577 (Dec 22, 1982) 13 figs, 1 table, 37 refs

Key Words: Helicopter noise, Noise generation

A theoretical and experimental investigation of the noise of a model helicopter rotor due to the ingestion of grid-generated, isotropic turbulence is described. Simulated forward flight and vertical ascent tests were performed with a 0·76 m diameter, articulated model rotor. Far field noise spectra and directivity were measured in addition to inflow turbulence intensities, length scales and spectra. Measured inflow turbulence statistics and rotor operating parameters were employed in a theoretical procedure to predict turbulence ingestion noise spectra and directivity.

This theoretical formulation represented an absolute level prediction method in that empirical or adjustable constants were not employed.

83-925

Rotorcraft Blade Mode Damping Identification from Random Responses Using a Recursive Maximum Likelihood Algorithm

J.A. Molusis

Ashford, CT, Rept. No. NASA-CR-3600, 50 pp (Sept 1982)

AD-A119 612

Key Words: Helicopters, Propeller blades, Modal damping, Natural frequencies, Recursive methods

An on-line technique is presented for the identification of rotor blade modal damping and frequency from rotorcraft random response test data. The identification technique is based upon a recursive maximum likelihood (RML) algorithm, which is demonstrated to have excellent convergence characteristics in the presence of random measurement noise and random excitation. The RML technique requires virtually no user interaction, provides accurate confidence bands on the parameter estimates, and can be used for continuous monitoring of modal damping during wind tunnel or flight testing. Results are presented from simulation random response data which quantify the identified parameter convergence behavior for various levels of random exictation.

83-926

Helicopter Vibration Suppression Using Simple Pendulum Absorbers on the Rotor Blade

G.A. Pierce and M.H. Hamouda

School of Aerospace Engrg., Georgia Inst. of Tech., Atlanta, GA, Rept. No. NASA-CR-3619, 140 pp (Sept 1982)

AD-A119 467

Key Words: Helicopter vibration, Vibration control, Propeller blades, Pendulums

The objectives of the present investigation are: develop a mathematical model to represent the blade-pendulum system; find the dynamic response characteristics of the blade-pendulum system, using the transfer matrix method; determine the optimum pendulum tuning to suppress the hub reactions; and conduct a parametric study of the optimum tuned configuration.

MISSILES AND SPACECRAFT

83-927

Hybrid Equations for Translational and Rotational Motion of Flexible Spacecraft

P.T.L.M. Vanwoerkum

National Aerospace Lab., Amsterdam, The Netherlands, Rept. No. NLR-TR-81116-U, 77 pp (Sept 29, 1981)

N82-31397

Key Words: Spacecraft, Equations of motion

Equations of motion of a generic spacecraft with a rigid main body, and with flexible appendages, rotors, and jets on or in the main body were obtained by hybrid coordinate modeling. The equations were linearized to obtain the motion equations of three-axis stabilized spacecraft. The reduction of the exact motion equations to those describing the motion of a multibody spacecraft, composed of rigid main body with finite moments of inertia and of point masses with zero moments of inertia, is outlined.

BIOLOGICAL SYSTEMS

HUMAN

(Also see No. 1052)

83-928

A Study of General Aviation Community Noise Impact and Annoyance

J.E. Mabry

MAN-Acoustics and Noise, Inc., Seattle, WA, Rept. No. MAN-1045, NASA-CR-165945, 45 pp (Apr 1982)

N82-31066

Key Words: Airports, Aircraft noise, Human response

The study involved the selection of three airports which were dominated by aircraft weighing 12,500 lbs or under and which were also undergoing a change relative to utilization. Also, there was interest in airports with different utilization levels so that effect of number of operations could be considered. In addition, there was a requirement to select airports with communities in the surrounding areas which were exposed to aircraft operations noise. Noise annoyance response data was obtained from available sources.

83-929

Minimum Noise Impact Aircraft Trajectories

R.G. Melton

Ph.D. Thesis, Univ. of Virginia, 210 pp (1982)
DA8228602

Key Words: Aircraft noise, Noise reduction, Human response

A method is developed for studying the feasibility of reducing annoyance due to aircraft noise by modifying the flight trajectories over a community. Numerical optimization is used to compute the optimum flight paths, based upon a parametric form that implicitly includes some of the problem restrictions. The other constraints are formulated as penalties in the cost function. Various aircraft on multiple trajectories (landing and takeoff) are considered. The modular design employed allows for the substitution of alternate models of the population distribution, aircraft noise, flight paths, and annoyance, or for the addition of other features (e.g., fuel consumption) in the cost function. A reduction in the required amount of searching over local minima is achieved through use of the presence of statistical lateral dispersion in the flight paths.

83-930

Traffic Noise Measurement and Analysis in Jeddah

A.I. El Sharkawy and A.A. Aboukhashaba

Mech. Engrg. Dept., King Abdul Aziz Univ., Jeddah, Saudi Arabia, Appl. Acoust., 16 (1), pp 41-49 (Jan 1983) 5 figs, 7 refs

Key Words: Traffic noise, Experimental test data, Human response

This paper presents measurements and analysis of traffic noise in the residential area of Jeddah City. These measurements are aimed to help in predicting the subjective response to noise as a function of measured predicted sound levels. Noise data were correlated to the individual respondent's reaction. Linear regression analyses were performed between noise exposure and dissatisfaction response.

83-931

The Determination of Mechanical Parameters of the Knee by Measuring Its Mechanical Impedance

E. Gražulis and V. Ragulskiene

Kaunas Politechnical Institute, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 61-64 (1981) 2 figs, 1 table
(In Russian)

Key Words: Knee (anatomy), Lumped parameter method, Mechanical impedance

The use of mechanical impedance in the development of a lumped parameter dynamic mathematical model of a human knee-cap is described.

ANIMAL

(See No. 1052)

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see No. 1022)

83-932

Procedure for Evaluation of Engine Isolators for Reduced Structure-Borne Noise Transmission

J.F. Unruh

Southwest Research Inst., San Antonio, TX, J. Aircraft, 20 (1), pp 76-82 (Jan 1983) 13 figs, 2 tables, 8 refs

Key Words: Isolators, Vibration isolators, Engine mounts, Aircraft engines, Noise reduction

Analytical models of a general aviation aircraft engine, vibration isolators, and engine mount structure are dynamically coupled to an empirical model of the aircraft fuselage for the purpose of developing a strucutre-borne interior noise transmission model. Laboratory base tests of the aircraft with isolators of various structural properties provided relative isolator performance data for correlation of the analytical model.

83-933

Vibration Isolation by Means of Air Damping (Schwingungsisolierung mit einstellbarer Luftdampfung)

G. Gürich and W. Settgast

Feinwerk u Messtechnik, 90 (8), pp 407-410 (1982)
10 figs, 11 refs
(In German)

Key Words: Vibration isolation, Damping

Vibration isolation by means of low tuned foundations must provide the best possible isolation against the high frequency vibrations in the environment, as well as the damping of random resonant vibrations. In this paper, vibration isolator elements with air damping are described. The response of these elements is compared with the isolation properties of viscous dampers by means of transmission measurement.

83-934

Optimal Passive Frequency Response Control of Large Vibrating Systems

L. Kitis
Ph.D. Thesis, Univ. of Virginia, 104 pp (1982)
DA8228609

Key Words: Absorbers (equipment), Vibration absorption (equipment), Optimization, Frequency response, Vibrating structures

Computational frequency response optimization methods for complex vibrating systems are developed using passive control techniques. Methods suitable for discrete systems with a large number of degrees of freedom are applied to obtain optimal broadband response. Reanalysis and modal techniques are used in the structural dynamic analysis phase of the design algorithm and optimization is carried out by a feasible directions approach.

83-935

Polyurethane Foams for Aircraft Shock Mounts. IV. Other Polyols

J.V. Duffy
Naval Surface Weapons Ctr., Silver Spring, MD, Rept. No. NSWC/TR-82-176, SBI-AD-F500 070, 29 pp (June 1982)
AD-A119 399

Key Words: Shock absorbers, Energy absorption, Airborne equipment response, Foams

A number of polyether polyurethane flexible foams are being developed as shock mitigators for electronic equipment aboard Navy aircraft. These foams are based on polyol mixtures derived from poly(oxytetramethylene) glycol and poly(oxypropylene)polyol. This report describes the effect that changes in the basic polyol composition has on the foam's vibration damping and mechanical properties.

83-936

The Multiobjective Decision on Parameters of Suspension System of Wheeled Vehicle

Jifa Gu and Junfang Gu
Acta Armamentarii, 1, pp 30-37 (1982)
CSTA No. 623.4-82.03

Key Words: Suspension systems (vehicles), Optimum design

Various control criteria in the suspension system of a vehicle can be established according to the theory of random vibration. In this paper the description begins with optimization of a mathematical model of a suspension system. The suspension parameters are optimized by use of the multiobjective decision methods with results obtained from an electronic computer.

83-937

Comparisons of Active, Passive and Semi-Active Suspensions for Ground Vehicles

P. Boonchanta
Ph.D. Thesis, Univ. of California, Davis, CA, 230 pp (1982)
DA8227859

Key Words: Suspension systems (vehicles), Active isolation, Semiactive isolation, Passive isolation, Active damping, Motorcycles

The comparison study is made of active, semi-active and passive suspension systems. A state-of-art review is presented and the discussion includes the optimization of a single-degree-of-freedom (SDOF) suspension system, its implementation and design evaluations. Different types of damping mechanism are also discussed. The concept of damping controllability is introduced and the eigenvalue movement due to damping parameter variations is considered. The influences of different types of damping in the frequency transmissibility of both the SDOF and 2DOF systems are studied.

TIRES AND WHEELS

83-938

An Analysis of Tire-Noise-Generating Mechanisms on Dry and Wet Road Surfaces - Part 2 (Untersuchung der Entstehungsmechanismen von Reifenabrollgeräuschen bei Trockenheit und Nässe - Teil 2)

W. Liedl, E. Kohler, and R. Eberspacher
Goethestrasse 43, 7261 Ostelsheim, W. Germany, Automobiltech. Z., 84 (12), pp 645-648 (Dec 1982) 6 figs
(In German)

Key Words: Tires, Noise generation, Interaction: tire-pavement

The state-of-the-art of tire noise on wet road surfaces is presented. It is influenced primarily by high levels of acoustic pressure above the frequency of 1 kHz.

BLADES

(Also see Nos. 926, 1057)

83-939

Shock Wave Boundary Layer Interaction in Compressor Cascades

Shen Yu
Acta Aeron. et Astron. Sinica, 3 (1), pp 45-49 (1982)
CSTA No. 629.1-82.06

Key Words: Cascades, Blades, Compressor blades, Interaction: shock waves-boundary layer

It is shown by calculation and analysis that the main form of interaction in compressor cascades is the interaction between shock wave and turbulent boundary layer in channels.

83-940

Vibrational Characteristics of Packeted Bladed Disc

M. Singh and D. Schiffer
McGraw Edison Co., Wellsville, NY, ASME Paper No. 82-DET-137

Key Words: Blades, Disks (shapes), Natural frequencies, Mode shapes, Finite element technique

Natural frequencies and normal modes of a packeted bladed disc were calculated using a three-dimensional finite element model. These results are compared with a similar study conducted on just one packet of blades fixed at base.

83-941

The Effects of Hull Pitching Motions and Waves on Periodic Propeller Blade Loads

S.D. Jessup and R.J. Boswell
David W. Taylor Naval Ship Res. and Dev. Ctr., Bethesda, MD, Rept. No. DTNSRDC-82/093, 65 pp (Sept 1982)
AD-A119 511

Key Words: Blades, Propeller blades, Marine propellers, Wave forces, Periodic excitation

Fundamental investigations were made of the effects of periodic hull pitching motions and waves on the periodic loads on propeller blades and bearings. These periodic loads were measured during carefully controlled model experiments in which the periodic hull pitching motions, regular waves, and relative phase of the hull pitching to the wave encounter were systematically and independently varied. The periodic blade loads were calculated using trochoidal wave velocity profiles, and representation of the propeller based on a quasi-steady method.

BEARINGS

(Also see Nos. 1050, 1051)

83-942

Characteristics of Squeeze Air Film Between Nonparallel Plates

H. Takada, S. Kamigaichi, and H. Miura
Dept. of Mech. Engrg., Univ. of Tokyo, Tokyo, 113 Japan, J. Lubric. Tech., Trans. ASME, 105 (1), pp 147-152 (Jan 1983) 13 figs, 4 refs

Key Words: Bearings, Squeeze-film bearings, Gas bearings, Dynamic response

The dynamic pressure in a squeeze film and the air flow through the film were analyzed experimentally and theoretically. The dynamic pressure was measured in a squeeze film between two rectangular plates with a small pressure transducer. Approximate solutions for the rectangular squeeze film were obtained analytically. The results were valid for small excursion ratios.

83-943

Influence of Gas Inertia Forces Generated Within the Stabilizing Restrictor on Dynamic Characteristics of Externally Pressurized Thrust Gas Bearings (1st Report, Case of Laminar Flow at the Capillary Restriction)

Y. Haruyama and H. Mori
Toyama Univ., 1-1, Nakagawa-Sonomachi, Takaoka, Japan, Bull. JSME, 25 (210), pp 2030-2038 (Dec 1982) 18 figs, 9 refs

Key Words: Bearings, Gas bearings, Stiffness coefficients, Damping coefficients

The influence of gas inertia forces generated within the stabilizing restrictor on the dynamic characteristics of externally pressurized circular thrust gas bearings with a stabilizer is investigated theoretically and experimentally. From comparison with the experiment, it is concluded that the influence on the dynamic characteristics is considerable, and the presented analysis yields good predictions for both the bearing stiffness and the damping coefficient in a wide range of designing conditions.

83-944

Gas-Lubricated Foil Bearings for Heat Pumps with Counter-Rotating Heat Exchangers

H. Hesmat
Mechanical Technology, Inc., Latham, NY, ASME Paper No. 82-DET-139

Key Words: Bearings, Foil bearings, Gas bearings

This paper presents the development work of counter-rotating, high-speed foil bearings as applied to a Rankine cycle, gas-fired heat pump under development for a residential application. The system is unique in that it uses two refrigerant fluids and in that it consists of two rotating elements: a high-speed turbomachine core and a low-speed element.

83-945

A Study on Characteristics of Surface-Restriction Compensated Gas Bearing with T-Shaped Grooves

K. Kogure, R. Kaneko, and K. Ohtani
Musashino Electrical Communication Lab., Nippon Telegraph and Telephone Public Corp., 3-9-11, Midori-cho, Musashinoshi, Tokyo, Japan, Bull. JSME, 25 (210), pp 2039-2045 (Dec 1982) 18 figs, 5 refs

Key Words: Bearings, Gas bearings, Stiffness coefficients, Damping coefficients, Perturbation theory, Finite difference technique

This paper reports on dynamic characteristics of a T-shaped groove bearing analyzed by the small perturbation method and results of an investigation by the modified finite difference method, which can rationally express any bearing surface division, including both groove and land parts, by only one grid. Based on these calculated results, design criteria are given for a high performance bearing with high stiffness and high damping values. Stability thresholds are also calculated.

83-946

Analysis of Externally Pressurized, Double-Pad, Gas Porous Thrust Bearing

K.H. Wu and C. Cusano
Univ. of Illinois at Urbana-Champaign, Urbana, IL 61801, J. Lubric. Tech., Trans. ASME, 105 (1), pp 113-119 (Jan 1983) 14 figs, 9 refs

Key Words: Bearings, Gas bearings, Porous materials, Stiffness coefficients

The local capacity and stiffness of double-pad circular and rectangular porous gas bearings are analytically studied. Design curves for load capacity and stiffness versus static bearing numbers, for different supply pressures and eccentricity ratios, are given. The load capacity and stiffness of both bearings reach a maximum value at some bearing numbers and then decrease. A comparison between the load capacity and stiffness of single and double-pad gas bearings is made.

83-947

Predicting the Effects of Lubricant Chemistry on Bearing Fatigue Life

R.E. Cantley
The Timken Co., Canton, OH 44706, ASLE, Trans., 26 (1), pp 80-86 (Jan 1983) 3 figs, 10 refs

Key Words: Bearings, Fatigue life, Lubrication

A method for predicting the effects of lubricant chemistry on bearing fatigue life is evaluated. The method is based on a correlation that is developed from wear test data, obtained with a ring-on-block tester, and full-scale bearing life test data. The correlation reveals that the degree of wear is inversely proportional to bearing fatigue life. The relationship

between wear and bearing life is developed by using both light- and heavy-viscosity base oils, single- and multicomponent-additive formulations, and various commercial lubricant formulations.

83-948

A Comparative Study of Some Two-Lobed Journal Bearing Configurations

M. Malik
Univ. of Roorkee, Roorkee 247 672, India, ASLE, Trans., 26 (1), pp 118-124 (Jan 1983) 10 figs, 1 table, 11 refs

Key Words: Bearings, Journal bearings

The two-lobed configurations considered for the present study are the elliptical bearing, offset-halves bearing, and two other configurations which are geometrical variations of the first two bearing forms. A comparison of their performance characteristics is obtained by theoretical analysis. It is shown that, unlike elliptical and offset-halves bearings, which have only limited range of effective dynamic performance, a two-lobe configuration can provide consistently good dynamic performance over a wide range of load conditions.

83-949

The Analysis of Hydrodynamic Journal Bearings Using Non-Newtonian Lubricants by Viscosity Averaging Across the Film

M. Malik, B. Dass, and R. Sinhasan
Univ. of Roorkee, Roorkee 247 672, India, ASLE, Trans., 26 (1), pp 125-131 (Jan 1983) 9 figs, 2 tables, 14 refs

Key Words: Bearings, Journal bearings, Hydrodynamic bearings, Lubrication

The analysis of hydrodynamic bearings using non-Newtonian lubricants is presented using a distinctly different approach. By integral averaging of the shear strain rate across the film, an averaged viscosity, which is only a function of the coordinates along the film, is defined. This makes it possible to apply the usual form of Reynolds equation. The steady-state pressure distribution is established by an iteration scheme which refines the viscosity field in successive steps. The performance characteristics results obtained from the analysis for a plane journal bearing with non-Newtonian lubricant following cubic shear stress law, compare very well with the experimental and theoretical results available in the published literature.

83-950

Dynamics of Pivoted-Pad Journal Bearings, Including Pad Translation and Rotation Effects

K.E. Rouch
Allis-Chalmers Corp., Milwaukee, WI 53201, ASLE, Trans., 26 (1), pp 102-109 (Jan 1983) 7 figs, 2 tables, 12 refs

Key Words: Bearings, Journal bearings, Tilting pad bearings, Translational response, Rotatory inertia effects

Pivoted-pad journal bearings are commonly applied to high-speed rotating equipment because of their potential for stable operation. Analysis of such bearings is complicated by the ability of each pad to pivot as the shaft is displaced, and to translate radially due to pivot flexibility. This leads to dependence of linearized stiffness and damping coefficients on shaft vibrational frequency, as well as shaft rotational frequency. Pad inertia and mass effects also couple into the response of the bearing, and become significant in large bearings. This paper describes an approach to combine the above effects with the pad assembly technique often used to develop bearing properties. A reduced matrix can be developed once a vibrational frequency is assumed. The approach provides a flexible, yet computationally efficient, means of obtaining bearing properties for rotor dynamics calculations.

83-951

Dynamic Behavior of a Journal Bearing in a Planet Gear

J.L. Nikolajsen and M. Botman
Pratt & Whitney Aircraft of Canada Ltd., Longueuil, Quebec J4K 4X9, Canada, ASLE, Trans., 26 (1), pp 87-93 (Jan 1983) 4 figs, 2 tables, 4 refs

Key Words: Bearings, Journal bearings, Planet gears, Computer programs

The dynamic analysis of the journal bearing which supports the planets of an epicyclic gear stage is described. The analysis includes an assessment of the damping characteristics of the bearing, the stability, and the response of the planet to gear mesh interactions between the sun, the planet, and the ring gear. A digital program is developed which provides the numerical solution of the equations of motion by forward integration in time. The full nonlinear expressions are used for both the hydrodynamic bearing forces and the gear mesh interaction forces.

83-952

The Significance of the Effective Viscosity in Non-stationary Loaded Journal Bearings

R. Langheim and W.J. Bartz
Inst. for Petroleum Res., D-3000 Hannover, W. Germany, ASLE, Trans., 26 (1), pp 69-79 (Jan 1983) 21 figs, 10 refs

Key Words: Bearings, Journal bearings, Lubrication, Viscosity

For pure hydrodynamic conditions in nonstationary loaded journal bearings, the viscosity characterizes the behavior of lubricants. Whereas the viscosity of Newtonian fluids changes with temperature and pressure, non-Newtonian lubricants are also affected by shear rate. These physical effects are not constant in circumferential and axial direction of a journal bearing. They form a definite viscosity distribution, which will be permanently changed by the varying conditions of dynamically loaded bearings. It is the object of this paper to define an effective value of viscosity concerning all these effects. Thus, determined effective viscosity is the basis of calculations which shall produce a better correlation to real conditions in journal bearings.

83-953
Dynamic Analysis of Rupture in Thin Fluid Films. 1-A Noninertial Theory

C.H.T. Pan
Columbia Univ., New York, NY 10027, J. Lubric. Tech., Trans. ASME, 105 (1), pp 96-104 (Jan 1983) 4 figs, 14 refs

Key Words: Bearings, Lubrication, Cavitation, Transient response

A noninertial theoretical model for the dynamics of film rupture is formulated. Under the transient condition, movement of the rupture boundary is governed by the condition of flow continuity between the film flux and adhered film transport in the cavitation domain. The traditional Swift-Stieber condition for film breakup is shown to be valid upon reaching steady-state. Generalization is extended to allow consideration of two sliding surfaces and the pure squeeze-film. The possibility of subcavitation film pressure is shown to result in dry regions in the cavitation domain.

83-954
Effect of Surface Ellipticity on Dynamically Loaded Cylindrical Bearings

P.K. Goenka and J.F. Booker
Sibley School of Mech. and Aerospace Engrg., Cornell Univ., Ithaca, NY 14853, J. Lubric. Tech., Trans. ASME, 105 (1), pp 1-12 (Jan 1983) 13 figs, 13 refs

Key Words: Bearings, Cylindrical bearings, Optimization, Dynamic response

The finite element formulation for regular cylindrical bearings is extended to include irregular (noncylindrical) bearing surfaces. The optimum bearing shape is sought for a specific duty cycle with a constant load and sinusoidal angular displacement. The optimization is done with a view to maximizing the minimum film thickness. For the purpose of optimization a one-dimensional cylindrical bearing is considered. The optimum among all elliptical shapes is found to combine a specifically elliptical sleeve and a perfectly circular journal.

83-955
The Effect of Air Bubbles in Lubricating Oil on the Static and Dynamic Characteristics of Friction Bearings (Einfluss des Luftblasengehalts im Schmierol auf die statischen und dynamischen Gleitlager-Kennwerte)

J. Kiciński
Jet Engine Institute of the Polish Academy of Sciences, Gdansk, Poland, Konstruktion, 34 (12), pp 479-483 (Dec 1982) 8 figs, 7 refs
(In German)

Key Words: Bearings, Lubrication

A mathematical model for the description cavitation in lubricating oil is presented. The pressure distribution in the entire cavitated lubricant film; i.e., in the range of positive pressure and in the cavitation zone, is determined by means of a modified Reynolds equation. The static and dynamic characteristics of bearings obtained by this model are compared with the calculation results for Reynolds boundary conditions. In this study the time-dependent viscosity of the mixture is also taken into consideration.

83-956
Approximation Methods for the Design of Non-vibrating Plane Rectangular Air Bearings (Näherungsverfahren zur Dimensionierung schwingungsfreier ebener rechteckiger Luftlager)

H. Donat
VEB Carl Zeiss JENA, East Germany, Feingerätetechnik, 31 (10), pp 452-457 (1982) 9 figs, 1 table, 6 refs
(In German)

Key Words: Bearings, Fluid-film bearings, Design techniques

A simple method for the design of air lubricated plane rectangular air bearings is presented. Such bearings are characterized by low friction, high accuracy, silence, low wear and cleanliness in operation. They are particularly suitable in the manufacture of precision instrumentation.

83-957

A Survey of Applications of EHL on Machine Elements

K. Holmberg

Metals Lab., Technical Research Centre of Finland, SF-02150 Espoo 15, Finland, Tribology Intl., 15 (3), pp 123-131 (June 1982) 15 figs, 63 refs

Key Words: Bearings, Rolling contact bearings, Gears, Elasto-hydrodynamic properties, Lubrication

Concentrated contacts in motion are found in most mechanical machines. The elasto-hydrodynamic lubrication (EHL) theory deals with the lubrication of moving concentrated contacts. The first important successful application of EHL was to rolling contact bearings. The theory can today be used by designers for optimizing bearing design and predicting bearing life, power loss, temperature and dynamic behavior. The application of EHL to gearing is more complicated. The simplified film thickness calculation methods for gears offer a practical way of making a rough estimation of the risk of failure. Methods for calculating the film thickness in the difficult transient contact conditions and along the gear contact have recently been developed. The application of EHL to the transient conditions in a cam and tappet contact is promising.

BELTS

83-958

Investigation of the Dynamic Equations for a Flexible Belt, Embracing with a Small Corner Vibrating Surface

P. Varanauskas and V. Nenorta

Kaunas Politechnical Institute, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 109-112 (1981) 1 fig, 6 refs

(In Russian)

Key Words: Belts (moving), Magnetic tapes, Moving strips, Ultrasonic vibration

The equations for the dynamic analysis of a moving magnetic belt excited by ultrasonic mechanical vibrations, are investigated. The accuracy of the method is illustrated.

GEARS

(Also see No. 957)

83-959

Hydrodynamic Axial Force Transmission in High Speed Drive Shafts (Hydrodynamische Axialkraftübertragung bei Wellen schnellaufender Getriebe)

H. Langer

J.M. Voith GmbH, Heidenheim, Germany, Konstruktion, 34 (12), pp 473-478 (Dec 1982) 14 figs, 5 refs

(In German)

Key Words: Gears, Power transmission systems

The recent rising requirements for compressors and steam turbine installations have renewed the interest in "pressure cam" (Druckhamm), a mechanical element developed about fifty years ago. The paper shows how modern calculation methods meet these requirements. Instructions for the design of various pressure cams and their applications, as well as for the design of pinion shafts for these pressure cams are given.

CLUTCHES

83-960

Transmission Characteristics of Electromagnetic Laminated Clutches (Untersuchungen zum Ubertragungsverhalten von Elektromagnet-Lamellenkupplungen)

J. Hennig, B. Kuhnast, and M. Woelk

Technische Universitat Dresden, German Dem. Rep., Maschinenbautechnik, 31 (12), pp 546-550 (1982) 6 figs, 5 refs

(In German)

Key Words: Clutches, Design techniques

Transmission characteristics of electromagnetic laminated clutches are described mathematically. Thus, the motion caused by the clutch-brake combination and the response of the drive system can be evaluated in the design phase. The results of the dynamic simulation and the measured motion are in close agreement. Two problems are also discussed: the step angle generated by step motion cannot

be exactly reproduced; and the size of the accelerations and disturbances does not always agree with motion requirements.

COUPLINGS

83-961

Size Selection of Torsionally Flexible Couplings (Zur Grössenauswahl drehnachgiebiger Kupplungen)

W. Gnilke

Bergakademie Freiberg, German Dem. Rep., Maschinenbautechnik, 31 (12), pp 537-540 (1982) 7 figs (In German)

Key Words: Couplings, Flexible couplings

Methods and data for the selection of torsionally flexible couplings for driving systems, where they are subjected to stationary vibrations and square wave collisions, are presented. The relationship between the theoretical models of machine dynamics and the structural design parameters is investigated. Numerical examples are used to illustrate this relationship.

83-962

The Effect of the Anisotropy of Couplings on Machine Vibrations

G. Maiorov

Vibrotechnika, 1 (39), pp 21-28 (1981) 5 figs, 7 refs (In Russian)

Key Words: Couplings, Rigid couplings, Rotating machinery, Anisotropy, Parametric vibration

The effects of anisotropy of rigid couplings on the vibration of rotating machinery in the presence of system defects are studied theoretically and experimentally. The theoretical expressions for the determination of parametrical vibrations are given. The theoretical results were confirmed by experiment.

83-963

Aspects of Further Development of Torsionally Flexible Shaft Couplings with Visco-Elastic Transmission Elements (Aspekte der Weiterentwicklung drehelastischer Wellenkupplungen mit viskoelastischen Übertragungselementen)

F. Leistner and E. Kurras

Technische Hochschule "Otto von Guericke" Magdeburg, German Dem. Rep., Maschinenbautechnik, 31 (12), pp 533-536 (1982) 9 figs, 3 tables, 11 refs (In German)

Key Words: Couplings, Flexible couplings, Torsional response

The new demands and characteristics of torsionally flexible couplings are described. The various metallic and nonmetallic transmission elements are discussed.

FASTENERS

(Also see No. 1052)

83-964

An Evaluation of Acoustic Emission for the Detection of Defects Produced During Fusion Welding of Mild and Stainless Steels

P.G. Bentley, D.G. Dawson, and D.W. Prine

Risley Nuclear Power Dev. Labs., UKAEA (Northern Div.), Risley, Warrington WA3 6AT, UK, Non-Destructive Testing Intl., 15 (5), pp 243-249 (Oct 1982) 7 figs, 5 tables, 4 refs

Key Words: Welded joints, Steel, Failure detection, Acoustic emission

Acoustic emission is being evaluated for the detection of defects during fusion welding. In these trials, both the US-GARD and UKAEA-RNL equipments were used to monitor deliberately introduced defects during welding of mild steel and stainless steel plates. The plates were then examined by conventional non-destructive testing methods to establish the presence of the intentional and some non-intentional defects, and the results compared with the indications given by acoustic emission.

VALVES

83-965

An Analytical Study of the Dynamics and Stability of a Spring Loaded Safety Valve

A. Singh

EPRI, Palo Alto, CA, Nucl. Engrg. Des., 72 (2), pp 197-204 (Sept 11, 1982) 14 figs, 8 refs

Key Words: Valves, Dynamic analysis

Spring loaded self-actuating safety valves are employed as part of the overpressure protection systems in various industrial applications. In order to design and predict their performance it is necessary to study the dynamic behavior of the valve over a range of fluid and system conditions. A one-dimensional model has been developed to study the effects of different valve parameters such as the spring-mass characteristics, geometry of internal parts, adjustment ring settings, bellows etc. which influence the dynamic behavior and stability of the valve. Analytical results for steam flow conditions are presented to demonstrate the relative effects of these parameters on the valve opening time, maximum lift, blowdown (upstream pressure differential between the valve opening and closing) and any oscillations of the valve stem.

83-966

Cavitation Noise from Butterfly Valves

W.J. Rahmeyer

Colorado State Univ., Fort Collins, CO 80523, Nucl. Engrg. Des., 72 (3), pp 297-301 (Oct 1, 1982) 1 fig, 3 tables, 7 refs

Key Words: Valves, Noise generation, Cavitation noise

Cavitation in valves can produce levels of intense noise. This paper discusses and presents experimental data for the cavitation noise limit as well as the cavitation limits of incipient, critical, incipient damage, and choking cavitation for butterfly valves. The main emphasis is on the design limit of cavitation noise, and a noise level of 85 decibels was selected as the noise limit. Tables of data and scaling exponents are included for applying the design limits for the effects of upstream pressure and valve size.

CAMS

83-967

An Experimental and Analytical Investigation of the Dynamic Response of High-Speed Cam-Follower Systems -- Part 1: Experimental Investigation

A.P. Pisano and F. Freudenstein

Xerox Corp., N. Tarrytown, NY, ASME Paper No. 82-DET-135

Key Words: Cam followers, Dynamic tests, Experimental test data

This paper is concerned with filling two gaps in the cam-design field: the absence of adequate measurements of the dynamic response of cam-follower systems and the need for the development of a predictive dynamic model for both normal and pathological system behavior. Part I presents the results of basic experiments on the dynamic response of a modern, high-speed cam-follower system. These data are believed to be the most comprehensive available in the open literature, and can now be used by research investigators both in understanding system response and in developing and evaluating predictive dynamic models.

83-968

An Experimental and Analytical Investigation of the Dynamic Response of High-Speed Cam-Follower Systems -- Part II: Experimental Investigation

A.P. Pisano and F. Freudenstein

Xerox Corp., N. Tarrytown, NY, ASME Paper No. 82-DET-136

Key Words: Cam followers, Springs, Continuous parameter method, Mathematical models

Part II describes the development of a predictive dynamic model of a high-speed cam-follower system in which the spring is modeled as a distributed-parameter element. The dynamic response requires the solution of a coupled set of differential equations, one ordinary and one partial. The dynamic model has the unique capability of faithfully reproducing the effect of the higher harmonics of the cam lift curve on system performance. The model is capable of accurately predicting both normal system response as well as pathological behavior associated with the onset of toss, bounce, and spring surge.

STRUCTURAL COMPONENTS

CABLES

83-969

Constant Twist Deformations of Cables

I.G. Tadjbakhsh

Dept. of Civil Engrg., Rensselaer Polytechnic Inst.,

Troy, NY, Intl. J. Engrg. Sci., 21 (3), pp 263-268 (1983) 2 figs, 8 refs

Key Words: Cables, Rods, Three dimensional problems, Dynamic stability

The 3-dimensional constant twist deformations of cables and rods of symmetrical sections are considered. It is shown that under the stated conditions, certain reductions can be achieved. The specific example of stability of helical equilibrium configuration is analyzed.

BEAMS

(Also see Nos. 995, 1052)

83-970

Integrating Matrix Formulations for Vibrations of Rotating Beams Including the Effects of Concentrated Masses

W D Lakin

Old Dominion Univ. Res. Foundation, Norfolk, VA, Rept. No. NASA-CR-165954, 17 pp (June 1982) N82-32008

Key Words: Beams, Rotating structures, Matrix methods

By expressing partial differential equations of motion in matrix notation, utilizing the integrating matrix as a spatial operator, and applying the boundary conditions, the resulting ordinary differential equations can be cast into standard eigenvalue form upon assumption of the usual time dependence. As originally developed, the technique was limited to beams having continuous mass and stiffness properties along their lengths. Integrating matrix methods are extended to treat the differential equations governing the flap, lag, or axial vibrations of rotating beams having concentrated masses.

83-971

On the Natural Frequencies and Modes of Beams Loaded by Sloshing Liquids

W. Soedel

School of Mech. Engrg., Purdue Univ., West Lafayette, IN 47907, J. Sound Vib., 85 (3), pp 345-353 (Dec 8, 1982) 3 figs, 4 refs

Key Words: Beams, Fluid-induced excitation, Sloshing, Natural frequencies, Mode shapes

Equations of motion for a beam carrying a channel of free surface liquid of rectangular cross section have been formulated and solved analytically in closed form for the case where the beam is simply supported and the liquid is connected at both ends to large reservoirs. Various special situations are discussed and effects that govern the interaction are pointed out.

83-972

Consistent Mass Investigation of the Coupled Flexure Torsion Vibration of Beams

M. Mobrem

Ph.D. Thesis, Univ. of California, Santa Barbara, CA, 118 pp (1982)
DA8224647

Key Words: Beams, Flexural vibration, Torsional vibration, Natural frequencies

This research analyzes the coupled natural frequencies of a beam for bending and torsion by consistent mass (matrix) method. The solutions of homogeneous differential equations governing the problem of static uncoupled bending and torsion are used as the shape functions for bending and torsion respectively for the consistent mass and stiffness matrices. A series of computer programs were written to solve the problem by the consistent mass method, finite difference method and also by a lumped mass method.

83-973

Vibration and Stability of Sandwich Beams with Elastic Bonding

S. Chonan

Dept. of Mech. Engrg., Tohoku Univ., Sendai, Japan, J. Sound Vib., 85 (4), pp 525-537 (Dec 22, 1982) 7 figs, 1 table, 17 refs

Key Words: Beams, Sandwich structures, Cantilever beams, Elastic core-containing media, Flexural vibration, Longitudinal vibration, Flutter, Natural frequencies

This paper is a study of the vibration and stability of symmetrical sandwich cantilevers with elastic bonding. Numerical results are given for a beam composed of FRP face layers and a syntactic-foam core layer. It is shown that the divergence and the flutter type instability loads, as well as the natural frequency, are affected considerably by the stiffness of the interface bond.

83-974

Dynamic Coefficient of a Two-Layered Thick Beam with Imperfect Bonding

S. Chonan
Dept. of Mech. Engrg., Tohoku Univ., Sendai, Japan,
J. Sound Vib., 85 (4), pp 539-550 (Dec 22, 1982) 6 figs, 9 refs

Key Words: Beams, Layered materials, Bonded structures, Elastic foundations, Impulse response, Transverse shear deformation effects, Rotatory inertia effects

This paper is concerned with the impulse response of a two-layered prestressed beam with flexible bonding resting on an elastic foundation. Two dissimilar layers of the beam are assumed to bend according to the Timoshenko beam theory. Numerical results are given for simply supported beams subjected to a uniformly distributed step load.

83-975

Parametric Vibrations of a Horizontal Beam with a Concentrated Mass at One End

H. Saito and N. Koizumi
Dept. of Mech. Engrg., Tohoku Univ., Sendai, Japan,
Intl. J. Mech. Sci., 24 (12), pp 755-761 (1982) 6 figs, 1 table, 5 refs

Key Words: Beams, Mass-beam systems, Parametric vibration, Periodic response

This investigation treats the steady state response of parametric vibration of a simply supported horizontal beam, carrying a concentrated mass at one end and subjected to a periodic axial displacement excitation at the other end under the influence of gravity. Non-linear terms arising from longitudinal inertia of a concentrated end mass and beam elements are included in the equation of motion.

83-976

On a Certain Property of the Natural Frequencies in the Lateral Vibration of a Beam Having a Circular Hole

M. Kataoka
Chiba Inst. of Tech., Narashino, Japan,
Bull. JSME, 25 (210), pp 1961-1968 (Dec 1982) 12 figs, 1 table, 4 refs

Key Words: Beams, Hole-containing media, Natural frequencies, Lateral vibration

It is shown that the natural frequencies in the lateral vibration of a beam having a circular hole, irrespective of the modes and its support conditions, vary with the position of the hole. The natural frequencies were computed according to Rayleigh's method using the deflection curves obtained by modifying the normal functions for the beam without a hole. The theoretical results were in good agreement with experimental results up to the first three natural frequencies.

83-977

Behaviour of Portal and Strut Types of Beam-Columns

D.J. Han and W.F. Chen
School of Civil Engrg., Purdue Univ., West Lafayette, IN 47907,
Engrg. Struc., 5 (1), pp 15-25 (Jan 1983) 22 figs, 20 refs

Key Words: Beam-columns, Tubes, Struts, Finite segment method, Influence coefficient method, Cyclic loading

A numerical procedure combining the finite segment method with the influence coefficient method has been developed for cyclic inelastic analysis of steel tubular beam-columns. In this paper, extensive numerical studies of the behavior of portal and strut-types of beam-columns under monotonic and cyclic loadings are made, using the computer model developed. These studies confirmed the suitability of the numerical procedure proposed. Comparisons have also been made with the results of tests on actual members, providing the needed confirmation of the validity of the method.

CYLINDERS

83-978

Radiation from a Dislocation Oscillating in a Circular Cylinder

A.I. Beltzer
School of Aerospace, Mechanical and Nuclear Engrg., Univ. of Oklahoma, 865 Asp Ave., Room 212, Norman, OK 73019,
Intl. J. Engrg. Sci., 21 (2), pp 165-170 (1983) 3 figs, 20 refs

Key Words: Cylinders, Acoustic emission, Resonant response

The exact closed-form solution is derived for standing waves due to an oscillating screw dislocation which is located in a circular infinite cylinder. The resonance behavior of the emitted waves and the effect of enery losses are explicitly shown.

FRAMES AND ARCHES

83-979

Recent Research on Eccentrically Braced Frames

E.P. Popov

Dept. of Civil Engrg., Univ. of California, Berkeley, CA, Engrg. Struc., 5 (1), pp 3-9 (Jan 1983) 18 figs, 18 refs

Key Words: Frames, Braces, Steel, Joints (junctions), Seismic design

Recent research developments on eccentrically braced steel frames for seismic design are reviewed. The emphasis is placed on the design of links, which are short sections of beams between columns and braces, and similar elements at eccentric joints. The review includes some highlights of the latest experiments with one-third scale models employing different eccentric bracing schemes, an updated classification of links, and special design requirements for different types of links. Some results are given on recent cyclic tests of full-size links.

83-980

Dynamic Stability of Plane Elastic Frames

G. Zingone and G. Muscolino

Istituto di Scienza delle Costruzioni, Facolta di Ingegneria, Universita di Palermo, 90128, Palermo, Italy, J. Sound Vib., 85 (3), pp 397-406 (Dec 8, 1982) 7 figs, 13 refs

Key Words: Framed structures, Vibrating foundations, Multistory buildings, Steel, Seismic excitation, Dynamic stability

The stability of plane elastic frames subjected to a vertical foundation motion of the stationary, ergodic type is investigated. The equations of motion are obtained in modal coordinates, with account taken of many modes of vibration. The problem is subsequently reduced to the study of only the first mode of vibration.

83-981

Aseismic Strengthening of Existing Reinforced Concrete Frames

Lian Wei and Dian Gu

J. of Building Structure, 3 (3), pp 46-55 (1982) CSTA No. 624-82.28

Key Words: Frames, Reinforced concrete, Seismic design

The importance as well as the necessity of the task of aseismic strengthening of existing structures in earthquake zones is elucidated. Basic principle and different strengthening measures are presented and discussed as a guidance for the aseismic strengthening of reinforced concrete frame structures. Some useful formulas for aseismic strengthening design based upon relevant experiments are also given.

83-982

Analytical Study of Irregular R/C Structures Subjected to In-Plane Earthquake Loads

M. Saiidi and K.E. Hodson, Jr.

College of Engrg., Univ. of Nevada, Reno, NV, Rept. No. COLLEGE OF ENGINEERING-59, NSF/CEE-82027, 163 pp (May 1982)
PB83-100404

Key Words: Frames, Reinforced concrete, Seismic response

A new version of a simple, single-degree model, the Q-model, is used for approximate displacement response history calculation of irregular planar reinforced concrete frames subjected to earthquakes. Nonlinearity of the response is accounted for at an idealized base sprung with a set of simple hysteresis rules and a full-scale hypothetical frame. The model is used to study the effect of several parameters on the seismic response. Effects of different earthquakes with the same spectral intensities on two structures are described.

PANELS

83-983

Parametrically Excited Non-Linear Multidegree-of-Freedom Systems with Repeated Natural Frequencies

E.G. Tezak, A.H. Nayfeh, and D.T. Mook

Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Sound Vib., 85 (4), pp 459-472 (Dec 22, 1982) 6 figs, 9 refs

Key Words: Natural frequencies, Parametric excitation, Panels, Flutter

A method for analyzing multidegree-of-freedom systems having a repeated natural frequency subjected to a parametric excitation is presented. Attention is given to the ordering of the various terms (linear and nonlinear) in the governing equations. The analysis is based on the method of multiple scales. As a numerical example involving a parametric resonance, panel flutter is discussed in detail.

83-984

Noise Transmission Loss of Aircraft Panels Using Acoustic Intensity Methods

M.C. McGary

NASA Langley Res. Ctr., Hampton, VA, Rept. No. L-15306, NASA-TP-2046, 37 pp (Aug 1982) N82-31069

Key Words: Panels, Aircraft, Structural members, Sound *transmission loss, Acoustic intensity method, Two micro*phone technique, Cross spectral method

The two-microphone, cross-spectral, acoustic intensity measurement technique was used to determine the acoustic transmission loss of three different aircraft panels.

PLATES

83-985

Axisymmetric Vibrations of an Isotropic Elastic Non-Homogeneous Circular Plate of Linearly Varying Thickness

J.S. Tomar, D.C. Gupta, and N.C. Jain

Dept. of Appl. Mathematics, Univ. of Roorkee, Roorkee 247672, India, J. Sound Vib., 85 (3), pp 365-370 (Dec 8, 1982) 2 figs, 8 refs

Key Words: Plates, Circular plates, Variable cross section, Axisymmetric vibrations

Free axisymmetric vibrations of an isotropic, elastic, non-homogeneous circular plate of linearly varying thickness have been studied on the basis of the classical theory of plates. The non-homogeneity of the material of the plate is assumed to rise due to the variation of Young's modulus and density with the radius vector whereas Poisson's ratio is assumed to remain constant. The governing differential equation of motion is solved by the method of Frobenius.

83-986

Shock Response of Viscoelastically Damped Sandwich Plates

A.S. Grover and A.D. Kapur

Dept. of Mech. Engrg., Punjab Engrg. College, Chandigarh, India, J. Sound Vib., 85 (3), pp 355-364 (Dec 8, 1982) 5 figs, 19 refs

Key Words: Plates, Sandwich structures, Damped structures, Viscoelastic damping, Viscoelastic core containing media

Analysis for the transient response of a simply supported three layer viscoelastically damped sandwich plate, subjected to a half sine shock pulse, has been carried out, with account taken of the transverse inertia effects only. The properties of the viscoelastic core material have been represented by those of a four element viscoelastic model. The influences of the variation of various geometrical and physical parameters of the damped sandwich plate on the shock response are investigated.

83-987

Flutter of a Buckled Plate as an Example of Chaotic Motion of a Deterministic Autonomous System

E.H. Dowell

Dept. of Mech. and Aerospace Engrg., Princeton Univ., Princeton, NJ 08544, J. Sound Vib., 85 (3), pp 333-344 (Dec 8, 1982) 9 figs, 16 refs

Key Words: Plates, Self-excited vibrations, Aeroelasticity, Flutter

For aeroelasticity of plates and shells, the equations of motion are well established. Results obtained by numerical time integration have been compared to those obtained by topological theories of dynamics and also from experiment. All of these suggest that chaotic self-excited oscillations may occur for this deterministic system.

83-988

Transverse Vibration of Clamped Trapezoidal Plates Having Rectangular Orthotropy

Y. Narita, K. Maruyama, and M. Sonoda

Dept. of Mech. Engrg., Hokkaido Inst. of Tech., Sapporo 061-24, Japan, J. Sound Vib., 85 (3), pp 315-322 (Dec 8, 1982) 4 figs, 2 tables, 14 refs

Key Words: Plates, Trapezoidal bodies, Orthotropism, Flexural vibration, Natural frequencies, Mode shapes

This paper deals with the free transverse vibration of orthotropic trapezoidal plates clamped at the edges. A series-type method is applied for obtaining an analytical solution of the problem, and the resulting frequency equation is presented for symmetric trapezoids. In the numerical study, accurate frequency parameters and mode shapes of the plates are calculated for the first several modes, and the effects of the orthotropy are discussed.

83-989

Vibrations of Initially Imperfect Circular Plates Including the Shear and Rotatory Inertia Effects

Z. Celep
Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Sound Vib., 85 (4), pp 513-523 (Dec 22, 1982) 5 figs, 17 refs

Key Words: Plates, Circular plates, Transverse shear deformation effects, Rotatory inertia effects, Flexural vibration, Geometric imperfection effects

An analysis of the free flexural vibrations of elastic circular plates with initial imperfections is presented. The analysis includes the effects of transverse shear and rotatory inertia. The vibration amplitudes are assumed to be large, and two nonlinear differential equations are obtained for free vibration of the plate and solved numerically. The period of the plate has been calculated as a function of the initial amplitude for four typical supporting conditions.

83-990

Receptances of Non-Proportionally and Continuously Damped Plates – Reduced Dampers Method

H.N. Özgüven
Dept. of Mech. Engrg., Middle East Technical Univ., Ankara, Turkey, J. Sound Vib., 85 (3), pp 383-395 (Dec 8, 1982) 5 figs, 3 tables, 28 refs

Key Words: Plates, Damped structures, Reduced dampers method

A method is presented for the dynamic analysis of continuously and nonproportionally damped plates in bending modes. The damping can be in the form of constrained or unconstrained layers. The method is an extension of the equivalent dampers method discussed in a previous paper, in which the damping matrix of a discretized plate is replaced by a diagonal equivalent damping matrix.

83-991

Free Vibration Analysis of Layered Plates and Composites by a Mixed Method: State Space Approach

S. Chandrashekara
Ph.D. Thesis, Georgia Inst. of Tech., 237 pp (1982) DA8229886

Key Words: Plates, Layered materials, Composite structures, Natural frequencies, State space approach

A mixed method of elastodynamics is presented in this thesis for analyzing the dynamic response of laminated plates and composites. The state-space method of analysis is used to reduce the governing three-dimensional equations of motion to a set of two-dimensional equations while keeping the field equations in their exact form. The method has been applied to the solution of natural frequencies for two-layered isotropic plates with various ratios of layer thicknesses and several cases of two-layered orthotropic plates with varying degrees of orthotropy of individual layers.

83-992

Fourier Series Solution for a Rectangular Thick Plate with Free Edges on an Elastic Foundation

D.J. Henwood, J.R. Whiteman, and A.L. Yettram
Dept. of Mathematics, Brighton Polytechnic, Brighton, Sussex, UK, Intl. J. Numer. Methods Engrg., 18 (12), pp 1801-1820 (Dec 1982) 9 figs, 6 tables, 6 refs

Key Words: Plates, Elastic foundations, Fourier analysis

A Fourier series solution is presented for a system of first-order partial differential equations which describe the linear elastic behavior of a thick rectangular plate resting on an elastic foundation and carrying an arbitrary transverse load. The lateral edges of the plate are unstressed. A central step in the method for solving the system of equations is to combine a complementary function with a particular solution of the system in order to satisfy the boundary conditions.

83-993

Dynamic Transmission Torque of a Flexible Multiple-Disc Clutch and Brake to Intermittent Loads

K. Nagaya, S. Takeda, K. Hirai, and S. Ikai
Gunma Univ., Kiryu, Gunma, Japan, Tribology Intl., 15 (3), pp 153-159 (June 1982) 10 figs, 5 refs

Key Words: Plates, Clutches, Brakes (motion arresters), Mechanical drives, Torque, Laplace transformation

This paper is concerned with a transmission torque of a flexible multiple-disc clutch subjected to dynamic loads. The analysis has been developed on the problem of the clutch subjected to a dynamic load which varies as a half-rectified sine function with time. In the analysis, the elastodynamic theory of a circular plate has been extended to this problem by application of the Laplace transform method.

83-994

Nonlinear Vibrations in Plates and Gongs

T.D. Rossing and N.H. Fletcher

Dept. of Physics, Univ. of New England, Armidale, New South Wales, 2351, Australia, J. Acoust. Soc. Amer., 73 (1), pp 345-351 (Jan 1983) 9 figs, 2 tables, 15 refs

Key Words: Plates, Bells, Nonlinear vibration

The sounds from certain types of gongs show a frequency shift, up or down, as the vibration decays. In order to understand this nonlinear behavior, the vibrations of a variety of flat and curved plates under varying amounts of radial tension or compression are studied.

83-995

Influence of Initial Deflection of Plate Girder Webs on Fatigue Crack Initiation

Y. Maeda and I. Okura

Dept. of Civil Engrg., Osaka Univ., Yamada-Oka 2-1, Suita, Osaka 565, Japan, Engrg. Struc., 5 (1), pp 58-66 (Jan 1983) 19 figs, 2 tables, 12 refs

Key Words: Girders, Plate girders, Fatigue life, Webs (supports), Initial deformation effects, Finite element technique

When a thin-walled plate girder is subjected to repeated bending, it is possible that three types of fatigue cracks may be initiated. Fatigue cracks initiated in the tension flange and at the terminal point of the transverse stiffeners in the tension zone of the web are the most common fatigue cracks in thick beams. In addition, fatigue cracks which occur at the toe on the web side of fillet welds connecting a compression flange to a web, can only be observed in thin-walled plate girders. The cracks are caused by secondary bending stresses produced by the out-of-plane movement of unavoidable initial deflections of the web under repeated in-plane bending. This influence of initial web deflections on the out-of-plane deformations of the web or the secondary bending stresses at the toe is examined by finite element analysis.

SHELLS

83-996

Dynamical Analysis of a Simply Supported Two Layered Half-Cylindrical Shell

O. Šimkova and Š. Markuš

Inst. of Machine Materials and Mechanics, Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnícky Casopis, 33 (6), pp 745-754 (1982) 2 figs, 3 tables, 5 refs

(In Slovak)

Key Words: Shells, Cylindrical shells, Machinery noise, Noise reduction

The frequency and modal analysis of a two-layered half-cylindrical shell is studied for free undamped vibrations. Equations of motion are solved for a structure with all edges simply supported. The analysis presented is a first approach to a more complex problem of layered shell-like structures used in the field of noise control of machinery by enclosures.

83-997

Vibration of Waffle Cylinders

R. Karmakar

Indian Inst. of Tech., Kharagpur, India, Aeronaut. J., 86 (859), pp 350-353 (Nov 1982) 6 figs, 10 refs

Key Words: Shells, Cylindrical shells, Stiffened shells, Vibration analysis, Energy methods

A vibration analysis of waffle cylinders with various stiffener configurations is made using the energy method. The frequency factors of the stiffened cylinders are obtained in terms of various non-dimensional parameters. To make a comparative study, the frequency factors are maximized for a fixed cylinder mass and stiffener eccentricity ratio.

83-998

On the Buckling and Vibration of Antisymmetric Angle-Ply Laminated Circular Cylindrical Shells

K.P. Soldatos

Dept. of Mechanics, Univ. of Ioannina, Greece, Intl. J. Engrg. Sci., 21 (3), pp 217-222 (1983) 5 figs, 14 refs

Key Words: Shells, Cylindrical shells, Buckling, Free vibration

The buckling and free vibration problem of a thin composite antisymmetric angle-ply laminated circular cylindrical shell is studied. The Donnell-type equations of motion, in terms of the shell middle surface displacement components, are used and solved approximately by means of Galerkin's method. Numerical results are presented and the expectation that the bending-stretching coupling phenomenon rapidly dies out as the number of layers increases is confirmed.

83-999

Deterministic and Stochastic Earthquake Response Analysis of the Containment Shell of a Nuclear Power Plant

A.H. Yousafzai and G. Ahmadi

Dept. of Mech. Engrg., Shiraz Univ., Shiraz, Iran, Nucl. Engrg. Des., 72 (3), pp 309-320 (Oct 1, 1982) 14 figs, 1 table, 56 refs

Key Words: Shells, Containment structures, Nuclear power plants, Seismic response, Natural frequencies, Mode shapes

Response of the containment shell of a nuclear plant to earthquake ground motion is considered. A finite element model of the structure is developed and SAP IV structural analysis program is employed for the determination of the frequencies and the corresponding mode shapes of the structure. The response of the containment shell to several past earthquakes are analyzed and the results are discussed.

83-1000

A Seismic Response Analysis of a Cylindrical Liquid Storage Tank on an Elastic Foundation

K. Fujita

Takasago Technical Inst., Technical Headquarters, Mitsubishi Heavy Industries, Ltd., Takasago, Hyogo Pref., 676, Japan, Bull. JSME, 25 (210), pp 1977-1984 (Dec 1982) 8 figs, 16 refs

Key Words: Shells, Cylindrical shells, Storage tanks, Fluid-filled containers, Elastic foundations, Seismic response, Interaction: structure-fluid

This paper presents a seismic response analysis of a cylindrical liquid storage tank on an elastic foundation subjected to a horizontal earthquake, which is based on the energy method considering the coupled effect between sloshing and bulging.

83-1001

Coupling Effect Between Liquid Sloshing and Flexible Fluid-Filled Systems

W.K. Liu and D.C. Ma

Northwestern Univ., Dept. of Mech. and Nuclear Engrg., Evanston, IL 60201, Nucl. Engrg. Des., 72 (3), pp 345-357 (Oct 1, 1982) 11 figs, 1 table, 20 refs

Key Words: Interaction: structure-fluid, Fluid-filled containers, Sloshing, Seismic analysis

Current practice in seismic design of flexible liquid-filled systems is reviewed. A coupled fluid-structure finite element method which considers the sloshing effect is developed for the seismic analysis of liquid-filled systems of various geometries with and without internal components. An analysis of the dynamic interaction between the structural vibration and liquid sloshing is also presented.

RINGS

(See No. 1040)

PIPES AND TUBES

83-1002

Seismic Risk to Pipelines with Application to Northern Canada

G.M. Atkinson, A.G. Davenport, and M. Novak

Faculty of Engrg. Science, The Univ. of Western Ontario, London, Ontario, Canada N6A 5B9, Can. J. Civil Engrg., 9 (2), pp 248-264 (June 1982) 11 figs, 1 table, 40 refs

Key Words: Pipelines, Seismic response

Proposed northern pipeline projects necessitate the estimation of seismic risk in the Arctic. Seismic risk estimates are commonly based on the procedures proposed by Milne and Davenport or those described by Cornell. A modified Milne and Davenport approach (based on the amplitude recurrence

distribution) appears to offer advantages in Northern Canada since it avoids the seismological problems of defining tectonic zones and maximum magnitudes. Uncertainties in the model assumptions are described by a factor having a log-normal distribution that modifies the predicted acceleration. The variability of the distribution can be adjusted regionally to reflect the quality and extent of seismic information.

83-1003

Response of Parallel-Flow and Counterflow Heat Exchangers to Sinusoidal Flow Rate Changes of Large Amplitude

I. Todo
Yokohama Natl. Univ., 156, Tokiwadai, Hodogaya-ku, Yokohama, 240 Japan, Bull. JSME, 25 (210), pp 1994-2001 (Dec 1982) 6 figs, 8 refs

Key Words: Heat exchangers, Fluid-induced excitation, Periodic excitation, Large amplitudes

A computational method is presented for obtaining the steady-state temperature responses of parallel-flow and counterflow heat exchangers subject to sinusoidal flow rate changes of large amplitude. The method is based on the assumptions that the fluids pass through a series of lumped heat exchangers with lumped capacitances and that the steady-state responses are to be expressed by Fourier series, and it enables one to reduce the computation time remarkably. The frequency- and amplitude-dependent describing functions between the input sinusoidal flow rate changes and the fundamental component of the steady-state response of the outlet temperature of tube-side or shell-side fluid are also derived. Numerical examples are given.

DUCTS

83-1004

The Application of Mode Coupling Theory to the Transmission of Sound in the Sidebranch of a Rectangular Duct System

T.L. Redmore and K.A. Mulholland
Dept. of Construction and Environmental Health, Univ. of Aston in Birmingham, Gosta Green, Birmingham B4 7ET, UK, J. Sound Vib., 85 (3), pp 323-331 (Dec 8, 1982) 6 figs, 15 refs

Key Words: Ducts, Branched systems, Ventilation, Sound transmission, Acoustic impedance

Mode coupling is applied to rectangular ducts of the size encountered in modern ventilation systems. Theory is developed to describe the transmission of sound along a straight duct, and along a sidebranch. Acoustic impedance boundary conditions at the duct walls are included. Experimental and predicted results are presented for the frequency spectra, cross-sectional variation and longitudinal variation in the entry and sidebranch ducts caused by a pure tone source.

83-1005

Duct Acoustics -- A Time Dependent Difference Approach for Steady State Solutions

A. Cabelli
Div. of Energy Tech., Commonwealth Scientific and Industrial Res. Organization, Melbourne, Australia, J. Sound Vib., 85 (3), pp 423-434 (Dec 8, 1982) 6 figs, 9 refs

Key Words: Ducts, Sound propagation

A time dependent numerical technique is developed to study the propagation of sound in ducts in the absence of flow. The method is shown to be stable and convergent for propagating and decaying modes. Sample calculations are compared with analytical solutions in straight ducts and with numerical and experimental results in a mitred bend.

83-1006

A Comparison of Measured and Computed Sound Pressure Levels in a Non-Uniform Acoustically Lined Duct

A. Cummings, A.V. Parrett, and R.J. Astley
Dept. of Mech. and Aerospace Engrg., Univ. of Missouri-Rolla, Rolla, MO 65401, J. Sound Vib., 85 (3), pp 407-414 (Dec 8, 1982) 3 figs, 12 refs

Key Words: Ducts, Acoustic linings, Sound pressure levels

A comparison of measured and numerically calculated acoustical fields is presented for a nonuniform lined duct in the absence of appreciable mean flow. The frequency range investigated includes the cut-on frequencies of several transverse modes in certain portions of the duct. Measured pressure fields are compared to those predicted by one and two dimensional numerical models.

BUILDING COMPONENTS

83-1007
Floor Vibration Measurements in a Shopping Centre
G. Pernica and D.E. Allen
Div. of Bldg. Res., Natl. Res. Council of Canada, Ottawa, Ontario, Canada K1A OR6, Can. J. Civil Engrg., 9 (2), pp 149-155 (June 1982) 7 figs, 2 tables, 5 refs

Key Words: Floors, Vibration measurement

Vibration measurements are correlated on five long-span floors in a two-story shopping center. The floors are used primarily as walking areas and are considered satisfactory with respect to floor vibrations. Three of the floors are steel beam composite concrete deck construction, and two are precast, prestressed, concrete beam construction. Dynamic characteristics of the floors as determined by the heel impact test were compared with quiet occupancy criteria. Calculations of fundamental frequency and initial peak acceleration from heel impact for the five floors are also presented and the results compared with measured values.

83-1008
Theoretical Models for Investigation of Sound Transmission through Isolation Layers in Staircase Systems
G. Rosenhouse and H. Ertel
Fraunhofer-Institut f. Bauphysik, Konigstrassle 74, D-7000 Stuttgart 70, Fed. Rep. Germany, Appl. Acoust., 16 (1), pp 51-66 (Jan 1983) 11 figs, 6 tables, 5 refs

Key Words: Staircases, Sound transmission, Structure-borne noise

The behavior patterns of staircase dynamic response to structure-born sound are given through analysis of two-dimensional models. Typical models of this kind include angular discontinuities which represent the intersection line between the horizontal slabs and the stair's slope. Numerical examples illustrate the effect of elastic isolation layers on the solid-borne transmission loss between the stairs and the other parts of the building, the strong coupling between the stairs and the building caused by substitution of the elastic isolation layers by rigid sound bridges, the dependence of the dynamic response of the staircase on frequency, and the coupling between the longitudinal and flexural waves due to the aforementioned angular discontinuities of the staircase system.

83-1009
Computer Analysis for Space Stiffness, Section *Forces and Displacements of a Helical Member*
Jiansheng Wu
J. Bldg. Structure, 2 (6), pp 1-11 (1981)
CSTA No. 624-81.102

Key Words: Staircases, Helical structures, Computer programs

The computation of a helical staircase is rather complicated. By applying Castigliano's theory, some derivation has been carried out to get the space stiffness matrix, forces and displacements at various sections along the helical member and used as the basis for a computer program. Thus, a helical staircase can be analyzed not only as a single member, but also as a member of a space structure, if necessary. A numerical example for computing a helical staircase as a single member is also given.

83-1010
Behaviour of R.C. Compression-Flexure Members under Cyclic Loading
Ju Min Shen, et al
China Civ. Engrg., 15 (2), pp 52-64 (1982)
CSTA No. 624-82.46

Key Words: Structural members, Reinforced concrete, Cyclic loading, Seismic response

The hysteresis characteristics and ductility of R.C. compression-flexure members under cyclic loading are investigated. Investigations were made through 32 specimens tests on the effect of different axial loading ratios, stirrup, and longitudinal steel reinforcement contents. Test results show that the effect of slip of bond at joint region on the deformation and hysteresis characteristics of the R.C. members is significant and should not be neglected.

ELECTRIC COMPONENTS

MOTORS

83-1011
Design and Operation of Linear Vibromotors for Instrumentation Technology (Dimensionierung und

Betriebsverhalten von Vibrationslinearantrieben für die Gerätetechnik)
H. Marth and B. Reinhold
AdW der DDR, Zentralinstitut f. Kybernetik und Informationsprozesse, East Germany, Feingeratetechnik, 31 (10), pp 450-452 (1982) 5 figs, 11 refs
(In German)

Key Words: Motors, Vibratory techniques

A motor for use in instrumentation technology is described. Unlike the usual quasistatic piezoelectric microstep motors, these transformers operate in the mechanical resonance. The transformation of ultrasound vibrations into continuous or step motion of the motor is achieved by eccentric micro-impacts. A simple mathematical model is used for this transmission of motion. From the solution of the nonlinear differential equation the velocity-force characteristics are calculated. Types of ceramics suitable for application are suggested. Experimental investigations confirm the theoretical results, as well as the prediction of wear at contact locations between transformer and rotor.

83-1012
Vibro-Impact Mercury Commutator Equipment Dynamics
G. Gvaldiene and V. Ragulskiene
Kaunas Politechnical Institute, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 113-118 (1981) 9 figs, 5 refs
(In Russian)

Key Words: Motors, Vibration response, Commutators

The results of a theoretical investigation on the dynamics of a vibro-impact mercury commutator are presented. An impact-rate characteristics survey is given. The influence of different parameters on the motion of the system is determined.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

83-1013
Linear Motion Measurements on the Surface of Acoustic Waves
A. Zhabarov, V. Snitko, and K. Ragulskis
Kaunas Politechnical Institute, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 75-78 (1981) 2 figs, 3 refs
(In Russian)

Key Words: Vibration measurement, Acoustic waves

The feasibility of using surface acoustic waves for linear motion measurments is reported. Design consideration and an alternate sensor are discussed.

83-1014
Textbooks and Periodical Literature in Acoustics
V.R. Miller
5331 Pathview Dr., Huber Heights, OH 45424, Shock Vib. Dig., 15 (1), pp 5-15 (Jan 1982) 3 tables, 202 refs

Key Words: Acoustic properties, Reviews

This paper presents a review of available textbooks on acoustics. The books are arranged to show the wealth of information that exists and the various aspects of acoustics, from theoretical considerations to practical and experimental applications. Periodical literature is also included.

83-1015
Solving the Parabolic Equation for Underwater Acoustic Propagation by the Split-Step Algorithm
L.F. Roche
Naval Res. Lab., Washington, DC, Rept. No. NRL-8607, 29 pp (Aug 30, 1982)
AD-A119 750

Key Words: Underwater sound, Sound propagation

Mathematical models of underwater acoustic propagation are used in designing, deploying, and using underwater acoustic surveillance systems. This report documents a package of computer programs which solves the parabolic equation for underwater acoustic propagation using a split-step algorithm.

SHOCK EXCITATION

83-1016
A Method to Compute the Force Signature of a

Body Impacting on a Linear Elastic Structure Using Fourier Analysis

G.J. O'Hara and R.S. Schechter

Naval Res. Lab., Washington, DC, Rept. No. NRL-MR-4875, 19 pp (Sept 17, 1982)

AD-A119 747

Key Words: Impact force, Signature analysis, Fourier analysis

A method is derived to compute the force signature of a body impacting on a linear elastic structure. The time history of the impacting force is reconstructed from the response to impulse and response to the force at various points on the structure. The method is quite general and is applicable to any linear structure. The method is tested on a two degree of freedom system with various applied forces and reconstructs the forces very accurately.

83-1017

A Proposal for the Compatibility of Static and Dynamic Seismic Base Shear Provisions of the National Building Code

W.K. Tso

Dept. of Civil Engrg. and Engrg. Mech., McMaster Univ., 1280 Main Street West, Hamilton, Ontario, Canada L8S 4L7, Can. J. Civil Engrg., 9 (2), pp 308-312 (June 1982) 3 figs, 2 tables, 6 refs

Key Words: Seismic design, Standards and codes

A comparison is made, based on static and dynamic base shear calculations for four types of simple structures; namely, uniform moment resisting frame structures, uniform ductile flexural wall structures, uniform reinforced concrete shear wall structures, and unreinforced masonry wall structures.

83-1018

Inelastic Response of Degrading and Nondegrading Systems under Seismic Actions

G.J. Al-Sulaimani

Ph.D. Thesis, The Univ. of Texas at Austin, 328 pp (1982)

DA8227623

Key Words: Seismic analysis, Inelastic response spectra

Seismic motions will cause structures to vibrate pushing them into the inelastic range if the earthquake is strong enough. The purpose of this work is to study the inelastic behavior of structures subjected to seismic actions and the factors affecting it. Hysteresis models developed here and in other works are studied and some are chosen to reflect different types of deterioration. Some of these deteriorations are stiffness degradation, stiffness and strength degradation, and pinching.

83-1019

The Condition of Higher Order Shock Wave in Three-Dimension Space

Weimin Fan and Weirong Sun

J. Shanghai Chiao Tung Univ., 1, pp 1-18 (1982)

CSTA No. 621-82.17

Key Words: Shock wave propagation

The paper is concerned with how to obtain condition of higher order shock wave in three-dimension space using the perturbation method. Zero-order condition of shock wave is Hugoniot condition; one-order condition of shock wave can be used as a modification of zero-order condition of shock wave.

VIBRATION EXCITATION

(Also see Nos. 1060, 1088)

83-1020

A Receptance Formula for General Second Degree Square Lambda Matrices

A.B. Palazzolo, B.P. Wang, and W.D. Pilkey

Dept. of Mech. and Aerospace Engrg., Univ. of Virginia, Charlottesville, VA, Rept. No. A-82-5, 33 pp (1982)

AD-A119 643

Key Words: Receptance method, Natural frequencies, Mode shapes, Harmonic response

A computational algorithm utilizing the free vibration modes of a structure is presented for calculating receptances. The usual eigen-system computed for large structural models is incomplete; hence the receptances are approximate. The formulas developed here increased receptance accuracy compared to classical spectral representations.

83-1021

On the Optimal Location of Vibration Supports

B.P. Wang and W.D. Pilkey
Dept. of Mech. and Aerospace Engrg., Univ. of Virginia, Charlottesville, VA, Rept. No. A-82-3, 8 pp (1982)
AD-A119 626

Key Words: Natural frequencies, Optimization

The problem of optimal positioning of vibration supports to raise the fundamental natural frequency of a system is studied. It is established that for the optimal locations criterion the corresponding lowest antiresonant frequency is a maximum. A numerical example illustrates this criterion.

83-1022

Optimal Vibration Reduction over a Frequency Range

W.D. Pilkey, L. Kitis, and B.P. Wang
Univ. of Virginia, Charlottesville, VA, Rept. No. A-82-1, 35 pp (1982)
AD-A119 605

Key Words: Vibration control, Harmonic excitation

This is a review of optimal vibration reduction techniques for systems subject to harmonic excitation over a frequency range. Only passive means of control are considered. The objective functions used for optimization are restricted to those which relate directly to some measure of frequency response.

83-1023

The Interaction Between Parametric and Self-Excited Vibrations with Coulomb's Friction

S. Yano
Dept. of Mech. Engrg., Faculty of Engrg., Fukui Univ., 9-1, 3-chome, Bunkyo, Fukui, Japan, Strojnicky Časopis, 33 (6), pp 681-699 (1982) 18 figs, 1 ref

Key Words: Coulomb friction, Self-excited vibrations, Parametric vibration

Approximated solutions on the interaction between parametric and self-excited vibrations are presented. Steady solutions in the region of parametric resonance of first and second order have a good accuracy. Approximated solutions outside the region of parametric resonance of first and second order give the maximum and minimum deflection of a beat vibration in a good accuracy. The influence of Coulomb's friction is considered.

83-1024

The Friction-Speed Relation and Its Influence on the Critical Velocity of Stick-Slip Motion

Chun Bo Li and D. Pavelescu
The Polytechnic Inst. of Bucharest, Splaiul Independentei 313, 79590, Bucharest, Romania, Wear, 82 (3), pp 277-289 (Nov 15, 1982) 12 figs, 11 refs

Key Words: Critical speeds, Stick-slip response

A discontinuous friction model which consists of two exponential functions of the relative speed is presented on the basis of experimental data on stick-slip motion. This friction model was verified by using the vertical displacement of the sliding body. Development of the two exponential expressions in a Taylor series allows a correlation with other friction models to be carried out. By using the friction model, with various treatments of the approach, the three different limiting conditions for the stability of stick-slip motion as indicated by Cockerham and Cole were defined.

83-1025

A Theoretical Investigation of Flow-Induced Instabilities in Compliant Coatings

A.D. Garrad and P.W. Carpenter
Wind Energy Group, Taylor Woodrow Construction, 309 Ruislip Road East, Greenford, Middlesex UB6 9BQ, UK, J. Sound Vib., 85 (4), pp 483-500 (Dec 22, 1982) 8 figs, 3 tables, 31 refs

Key Words: Coatings, Fluid-induced excitation

The flow-induced instabilities of a fairly general class of compliant coatings are investigated theoretically. The coatings are of finite length and consist of elastic plates or membranes stretched over a fluid substrate having a density which may be different from the main flow. Provision is also made for the plate to be backed by an elastic foundation of arbitrary spring stiffness. Fairly standard aeroelastic methods are followed.

83-1026

Some Problems in the Ground Vibration Analysis

Yisun Wang

J. of Building Structure, 3 (2), pp 56-67 (1982)

CSTA No. 624-82.13

Key Words: Ground vibration, Harmonic excitation, Point source excitation, Vibration control

Exact solutions of displacement of a homogeneous, isotropic, elastic half-space surface of arbitrary Poisson's ratio under a vertical and a horizontal harmonic point load are given. Some problems of attenuation of the ground vibration are analyzed by means of the exact solution and the method of influence function of circle center displacement. The method is applicable for analyzing the ground displacement of near-field. The rationality of Barkan's discriminant for the far-field is discussed. The analysis shows that increasing the excitation frequency of the source reduces the decay rate of the ground vibration.

83-1027

Linear Structural Responses to Evolutionary Random Loads

G.P. Solomos

Ph.D. Thesis, The Univ. of Texas at Austin, 168 pp (1982)

DA8227724

Key Words: Oscillators, Damped structures, Random excitation

The statistics of the motion of a lightly damped linear single-degree-of-freedom oscillator is investigated. The oscillator is driven by a non-stationary excitation possessing a broad-band evolutionary power spectrum. Based on the assumption of light damping, the equations of motion for the amplitude and phase are averaged. The equations which are derived by this procedure allow the modeling of certain response parameters as Markov processes; associated with this modeling is the Fokker-Planck equation governing the evolution of the probabilistic structure of the Markov process.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 880, 925, 933, 937, 1022)

83-1028

Asymptotic Stability of Partially Damped Mechanical Systems

Weibin Gao

Acta Aeron. et Astron. Sinica, 3 (1), pp 58-66 (1982)

CSTA No. 629.1-82.08

Key Words: Damped structures, Gyroscopic effects, Stability

The asymptotic stability of a partially damped linear mechanical system with gyroscopic forces is studied. The equation of motion for the system is a second order linear matrix differential equation. Several cases with different gyroscopic couplings are discussed. The stability condition is not only simpler than that obtained by former authors, but also gives some insight to the mechanical properties of the system since it may then be considered as two coupled subsystems.

83-1029

Designing of Viscous Torsional Vibration Dampers for Reciprocating Engines (Auslegung von Viskose-Drehschwingungsdampfern fur Hubkolbenmotoren)

K. Federn

Instituf f. Konstruktionslehre und Thermische Maschinen der Technischen Universität, Strasse des 17. Juni 135, H 2027, D-1000 Berlin 12, Germany, MTZ Motortech., Z., 43 (11), pp 515-518, 521, 522 (Nov 1982) 9 figs, 23 refs

(In German)

Key Words: Vibration dampers, Viscous damping, Torsional vibration, Reciprocating engines

Fundamentals, pre-requisites and calculation methods for reliable designing of viscous torsional vibration dampers were studied. Following an extensive analysis of some previous failures in service, the material properties of silicone oils; i.e., their loss modulus and spring modulus under harmonic alternating shear, were measured by means of a new vibro-viscosimeter with a fully enclosed working-gap and at constant shear-rate amplitudes in the frequency range from 20 to 300 Hz and at various temperatures.

FATIGUE

(Also see No. 1058)

83-1030

Gel Electrode Imaging of Fatigue Cracks in Aluminium Alloys

W.J. Baxter
General Motors Res. Labs., Warren, MI 48090, Intl. J. Fatigue, 5 (1), pp 37-42 (Jan 1983) 14 figs, 4 refs

Key Words: Fatigue life, Aluminum, Failure detection

Previous papers have described a gel electrode technique recently devised for detecting and imaging fatigue cracks in aluminium tested in simple bending. In this study, the technique is shown to be applicable to testing in both bending and torsion and to high strength aluminium alloys 7075-T6, 2024-T3 and 2024-T4. Fatigue cracks as short as 10 μm in length are consistently detected and located.

83-1031
The Fatigue Crack Growth under Variable Amplitude Loading in Built-Up Structures

A. Salvetti, G. Cavallini, and L. Lazzeri
Inst. di Aeronautica, Pisa Univ., Italy, Rept. No. DA-ERO-78-G-107, 124 pp (Apr 1982)
AD-A119 764

Key Words: Fatigue life, Aluminum

Seventy-four specimens made of 2024-T3 aluminum alloy were tested both at constant and variable amplitude loading. The specimens were both simple sheets and riveted stiffened panels. The constant amplitude tests on simple sheet specimens were conducted in order to obtain the average K-rate relationship and the relevant scatter of the batch of sheets. The constant amplitude tests of stiffened panels aimed at obtaining information on the overall junction flexibility. Variable amplitude tests were performed. The data from sheet specimens was used to assess the reliability of prediction methods and the stiffened panels test data to evaluate how these methods work in the case of built-up structures.

83-1032
Cast Transage 175 Titanium Alloy for Durability Critical Structural Components

F.A. Crossley and W.J. Barice
Lockheed Missiles & Space Co., Sunnyvale, CA, J. Aircraft, 20 (1), pp 66-69 (Jan 1983) 7 figs, 2 tables, 9 refs

Key Words: Fatigue life, Alloys, Machinery components

Limited fatigue data are reported for cast-to-size plus hot isostatically processed tensile test bars of the martensitic Transage 175 alloy. The testing was done to assess the potential of the alloy for castings of rotating engine components such as impellers and fan rotors.

83-1033
A Local Strain Fatigue Analysis Method and Computer Program

Yisheng Wu
Acta Aeron. et Astron. Sinica, 3 (1), pp 37-44 (1982)
CSTA No. 629.1-82.05

Key Words: Fatigue life, Computer programs

A local strain fatigue analysis method is presented for evaluation of fatigue life. The three parameter elements of load increment, strain increment and stress increment are constructed by using the cyclic stress-strain curve of the material and the cyclic load notched strain curve of notched specimens. The local stress-strain analysis of notched specimens under complex load is made by means of these elements and availability coefficient matrix. The damage of each cycle is determined on the basis of local strain amplitude and correction for the effect of mean stress. The damage can be cumulated according to Miner's linear cumulative damage theory and the life can be evaluated.

83-1034
Fatigue of Metal Structures Sustaining a Very Large Number of Load Cycles. The Fatigue Threshold Concept

A.F. Blom
Aeronautical Res. Inst. of Sweden, Stockholm, Sweden, Rept. No. FFA-TN-1982-06, 13 pp (Apr 1982) (Pres. at Intl. Assoc. for Bridge and Struc. Engr. (Iabse) Colloq. on Fatigue of Steel and Concrete Struc., Lausanne, Switzerland, Mar 24-26, 1982)
N82-30580

Key Words: Fatigue life, Metals

The fatigue threshold stress intensity factor (Delta Kth) was evaluated. The influence of crack size, loading modes, stress ratio, thickness, frequency, microstructure, amplitude, temperature, and environment on Delta K is considered. Applications of Delta Kth are quoted. Specimens and test equipment for economical testing are discussed.

83-1035

Flexural Fatigue Behavior of Steel Fiber Reinforced Concrete

M.R. Galhoud

Ph.D. Thesis, The Univ. of Texas at Austin, 281 pp (1982)

DA8227648

Key Words: Concretes, Reinforced concretes, Fatigue tests

The effect of repeated loading on the mechanical properties and flexural behavior of concrete reinforced with short pieces of randomly distributed steel fibers is studied. The correlation between ultimate static flexural strength and fiber content and concrete compressive strength are also studied, and expressions for these relations are obtained. The static cracking strength results obtained in this study showed good agreement with the theoretical results predicted using the theory suggested by Romualdi based on fracture mechanics.

83-1036

On the Influence of Rubbing Fracture Surfaces on Fatigue Crack Propagation in Mode III

E.K. Tschegg, R.O. Ritchie, and F.A. McClintock

Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, Intl. J. Fatigue, 5 (1), pp 29-35 (Jan 1983) 9 figs, 2 tables, 28 refs

Key Words: Fatigue life, Torsional excitation, Steel, Crack propagation

Fatigue crack growth is studied under fully reversed torsional loading ($R = -1$) using AISI 4340 steel, quenched and tempered at 200°, 400° and 650°C. Only at high stress intensity ranges and short crack lengths are all specimens characterized by a macroscopically flat Mode III (anti-plane shear) fracture surface. At lower stress intensities and larger crack lengths, fracture surfaces show a local hill-and-valley morphology with Mode I, 45° branch cracks.

83-1037

A Review of Aero-Generator Fatigue Problems

A.J. Pretlove and P.J. Worthington

Dept. of Engrg., Univ. of Reading, Reading, UK, Intl. J. Fatigue, 5 (1), pp 15-22 (Jan 1983) 7 figs, 16 refs

Key Words: Fatigue life, Windmills, Power plants (facilities)

Aero-generators are high technology windmills designed primarily to generate electricity. To be economic, compliant designs must be used, in which thinner sections reduce material costs, but this exacerbates already serious fatigue problems. This paper describes the sources of fatigue loading for both horizontal-axis and vertical-axis machines.

83-1038

Fatigue Strength in Long Life Range and Non-propagating Fatigue Crack in SUS 304 Type Stainless Steel

K. Hatanaka and S. Shimizu

Yamaguchi Univ., Ube, 755, Japan, Bull. JSME, 25 (210), pp 1859-1866 (Dec 1982) 14 figs, 3 tables, 25 refs

Key Words: Fatigue life, Steel, Rotating structures, Cyclic loading

Rotating bending fatigue tests were performed for SUS 304 stainless steel which had various grain sizes. The fatigue limit of a plain specimen is much higher than the 0.2% proof stress, and the increase in the fatigue limit caused by the coaxing effect amounts to about 40% of that in the test under the condition of constant stress amplitude. The strain measured by using a slip ring shows that these results are due to a marked hardening produced during cyclic stressing.

ELASTICITY AND PLASTICITY

83-1039

Acoustic Propagation in Random Layered Media

H. Levine and J.F. Willemsen

Schlumberger-Doll Research, P.O. Box 307, Ridgefield, CT 06877, J. Acoust. Soc. Amer., 73 (1), pp 32-40 (Jan 1983) 16 figs, 7 refs

Key Words: Elastic waves, Wave propagation, Layered materials, Monte Carlo method

A study is made as to how the presence of small scale random layering may affect the interpretation of acoustic scattering data. Methods include theoretical analysis based on the idea of localization of states, in conjunction with Monte Carlo simulations of particular layered systems suggested by interesting geophysical examples. It is shown that the random layering can produce dramatic effects by leading to a cutoff frequency for transmission through the system.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

83-1040
The Dynamics of Motion of Two-Dimensional Vibrating Transformers
R. Kurilo, K. Ragulskis, and P. Satkus
Kaunas Politechnical Institute, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 29-34 (1981) 8 figs, 1 refs
(In Russian)

Key Words: Rings, Transfomers

The dynamics of a moving ring, caused by high frequency vibrations of resonant high frequency piezoelectric ceramic vibrator, are presented. The mathematical model is developed and it is used to analyze the transient and stationary response of continuous motion. The article also lists the basic characteristics of the transformer.

83-1041
Recognizing System Non-Linearities Using Modal Analysis Tests
S.C. Ulm and I.E. Morse
Structural Dynamics Res. Corp., Milford, OH, ASME Paper No. 82-DET-138

Key Words: Modal tests, Nonlinear systems

Structural nonlinearities are often ignored when modal analysis tests are performed. This can lead to errors if the presence of the nonlinearity is not known. This paper presents some warning signs that can alert the test engineer or technician that the system being investigated is nonlinear.

83-1042
Empirical Modal Analysis
M.N. Rizai, J.E. Bernard, and J.M. Starkey
Dept. of Mech. Engrg., Michigan State Univ., East Lansing, MI 48824, Shock Vib. Dig., 15 (1), pp 25-30 (Jan 1982) 56 refs

Key Words: Modal analysis, Modal tests, Reviews

Test apparatus that digitize analog signals and use fast Fourier transforms and related analytical tools to determine natural frequencies and mode shapes are now routinely available to test engineers. The equipment and associated test techniques, called modal testing, are now an important aspect of structural analysis in the initial design process, in design verification, and in troubleshooting. This paper presents a short history of modal testing and a review of developments over the last seven years, including multiple-point excitation and design modification based on modal test results. The paper concludes with a brief review of the closely related topic of acoustic intensity.

83-1043
Phase Noise Measurement Systems
A.L. Lance, W.D. Seal, and F. Labaar
TRW Electronics and Defense, ISA, Trans., 21 (4), pp 37-43 (1982) 12 figs, 13 refs

Key Words: Phase data, Measurement techniques, Frequency domain method, Spectrum analyzers

Phase noise is the term widely used to describe the characteristic randomness of frequency. Automation of phase noise measurements has been developed with satisfactory results using two techniques referred to as the two-oscillator technique and the single-oscillator technique. Measurements are performed in the frequency domain using a spectrum analyzer, which provides a frequency window following the phase or frequency detector. State-of-the-art-systems include system modifications for cross-spectrum measurements and techniques used to improve the noise floor characteristics of the delay line FM discriminator in order to measure single sources that have very low phase noise characteristics.

83-1044
Experimental Determination of Mechanical Impedance through Strain Measurement on a Conical Rod
L. Lagerkvist and K.G. Sundin
Dept. of Mech. Engrg., Univ. of Lulea, S-951 87 Lulea, Sweden, J. Sound Vib., 85 (4), pp 473-481 (Dec 22, 1982) 4 figs, 1 table, 4 refs

Key Words: Mechanical impedance, Measuring instruments, Measurement techniques

An impedance gauge based on measurement of strains at two different cross-sections of a conical gauge rod is tested. The gauge rod is in contact with the object at its narrow end while its wide end is driven by a harmonic vibrator. For cylindrical test objects a fair agreement is generally obtained between experimental and theoretical point impedances in the frequency range 50 Hz to 5 kHz.

83-1045

Update: Low Frequency, Real Time FFT Spectrum Analyzers

W. Yates

Electronic Products, 25 (11), pp 87-89 (Feb 7, 1983) 2 figs

Key Words: Spectrum analyzers

Two new spectrum analyzers are discussed. One is a four-channel unit that may be more computer than spectrum analyzer; the other is a two-channel analyzer that incorporates a new type of excitation source for measuring transfer functions. Priced at the lower end of the two-channel cost spectrum, it provides an excellent price/performance ratio.

83-1046

Integrating a Scope, DMM, and Counter/Timer Simplifies Measurements

C. Diller and T. Beazley

Tektronix, Inc., Beaverton, OR, Electronic Products, 25 (11), pp 93-96 (Feb 7, 1983) 3 figs

Key Words: Oscilloscopes, Measuring instruments

A portable scope weighing only 16.5 lbs., the 2236, in which the counter/timer operations and the digital multimeter capabilities are integrated, is described. It features 100 MHz, dual-channel operation plus trigger view. The counter/timer and multimeter are fully integrated into the scope's vertical, horizontal, and triggering systems, providing higher than usual measurement capabilities.

83-1047

The Design of Digital Filters Using Computer Aided Methods

P. Arnio, I. Hartimo, K. Kronloef, O. Simula, and J. Skyttae

Dept. of Technical Physics, Helsinki Univ of Tech., Espoo, Finland, Rept. No. TKK-F-A454, ISBN-951-752-317-3, 38 pp (June 25, 1981) PB83-101972

Key Words: Filters, Digital filters, Computer programs, Design techniques, Computer-aided techniques

The design of digital filters is cumbersome to be done by pen and paper. A collection of computer programs has been installed to form an effective design tool. It includes programs from various sources most of them being, however, accomplished within this project. Starting from the basic filter specifications it is possible to achieve the z-plane representation in various forms. Depending on the restrictions of the realization media parallel, cascaded, lattice, or state space form can be achieved. The resulting filter can be effectively simulated to obtain the amplitude, phase, and noise characteristics.

DYNAMIC TESTS

83-1048

Specimen Scale Effects in Cavitation Damage by the Direct Vibratory Method

Y. Abe

Meiji Univ., 214 Tama-ku, Kawasaki, Kanagawa Prefecture, Japan, Bull. JSME, 25 (210), pp 1876-1881 (Dec 1982) 20 figs, 10 refs

Key Words: Vibratory techniques, Testing techniques, Cavitation

In this paper the most applicable diameter of specimen is searched for through the direct vibratory damage-experiments conducted with various frequencies and amplitudes.

83-1049

The Dynamic Characteristics of Bridges through the Design of a Unique Bridge Vibration Machine

G.A. Arroyo Rizo Patron

Ph.D. Thesis, New Mexico State Univ., 182 pp (1982) DA8228164

Key Words: Vibration tests, Test equipment and instrumentation, Vibrators (machinery), Bridges, Seismic response, Earthquakes

The purpose of this research was to develop and/or test reliable field equipment for the dynamic testing of bridges. Prior to this research was the construction of a portable nondestructive bridge vibration machine. The machine is capable of producing a unidirectional sinusoidally varying force at a controlled frequency. At present, the machine generates a vertical force, but due to a unique design, would be able to generate a horizontal force with only slight modifications.

DIAGNOSTICS

83-1050

Improvement of Railroad Roller Bearing Test Procedures and Development of Roller Bearing Diagnostic Techniques. Volume 1: Acceptance Test

W.D. Waldron, J.M. McGrew, and A.I. Krauter

Shaker Res. Corp., Ballston Lake, NY, Rept. No. DOT-TSC-FRA-81-15-1, 246 pp (Mar 1982)
PB83-107946

Key Words: Bearings, Roller bearings, Spalling, Diagnostic techniques

Bearing defect data from 8,000 railroad roller bearings are analyzed to determine their defect modes and defect rate distributions. Cone bore growth, brinelling, and fatigue are identified as the predominant defect modes during the first 12 years of the aging process. The results of the study show that after approximately two years of service, 10 percent of all railroad roller bearings exhibit a defect of one type or another for which at least one component would be condemned if it were in a rework shop.

83-1051

Improvement of Railroad Roller Bearing Test Procedures and Development of Roller Bearing Diagnostic Techniques. Volume II: Diagnostics

W.D. Waldron, J.M. McGrew, A.I. Krauter, and J.L. Frarey

Shaker Res. Corp., Ballston Lake, NY, Rept. No. DOT-TSC-FRA-81-15-11, 165 pp (Apr 1982)
PB83-107953

Key Words: Diagnostic techniques, Bearings, Roller bearings, Railroad cars

A comprehensive review of existing basic diagnostic techniques applicable to the railcar roller bearing defect and failure problem was made. Of the potentially feasible diagnostic techniques identified, high frequency vibration was selected for experimental evaluation because it showed the most promise for implementation over a wide range of railroad deployment location requirements (from certification laboratory to trackside) and because it showed promise of being cost-effective while still providing a great deal of quantitative information regarding bearing condition.

83-1052

The Vibrational Characteristics of Uniform Bars Containing a Symmetric Discontinuity in Stiffness Applied to Structural Integrity Monitoring

W.T. Springer

Ph.D. Thesis, The Univ. of Texas at Arlington, 250 pp (1982)
DA8227450

Key Words: Diagnostic techniques, Crack detection, Beams, Bolts, Bones

Closed-form eigenvalue expressions have been developed for both the longitudinal and transverse vibration of uniform bars containing a symmetric discontinuity in cross-sectional area. Both of these expressions were generated using three receptance elements to model the bar, and were developed without regard to boundary conditions. These general expressions were then applied to the specific problems of the longitudinal vibration of a free-free beam, and the transverse vibration of a fixed-free beam. In both cases, the structural frequency response function was used to experimentally determine the natural frequencies.

83-1053

Acoustic Emission Analysis of Woven Graphite-Epoxy Composite Materials

R.G. Clinton

Ph.D. Thesis, Georgia Inst. of Tech., 482 pp (1982)
DA8229890

Key Words: Acoustic emission, Composite materials, Failure detection

The capability of acoustic emission to be successfully used as a means of detecting damaged or substandard composites was evaluated on the basis of analysis of data recorded during tensile tests on various graphite-epoxy laminates. Initially, the behavior of composites of differing resin contents, reinforced with unidirectional or woven graphite yarns was compared. Specimens containing fabrication defects, such as

damaged fiber bundles and areas of matrix and void concentrations, were identifiable by their acoustic emission responses if such flaws influenced the ultimate strength. Selected specimens were examined using a scanning electron microscope; representative areas and defects were photographed. The objective of the subsequent research program was to determine whether laminates which had been exposed to a hygrothermal environment were qualitatively and quantitatively identifiable using acoustic emission. The objective was accomplished with a three-phased approach.

83-1054
Acoustic Emission Source Location: A Mathematical Analysis

F.R. Redfern and R.D. Munson
Denver Res. Ctr., Bureau of Mines, Denver, CO, Rept. No. BUMINES-RI-8692, 34 pp (Aug 1982)
PB83-111245

Key Words: Acoustic emission, Sound source identification, Least squares method

Newton's method of solving a nonlinear equation is employed to develop a least-squares acoustic emission source location method in which the spatial residuals of the location equations are minimized. These residuals, related to the distances from the least-squares source location perpendicular to the surfaces described by the location equations, permit location error to be estimated to first order along the spatial axes. The solutions obtained by this method are the best spatial solutions to the location equations in the least-squares sense. Also presented is a procedure by which the geometrical control of a transducer array can be evaluated using the rate of change of source location with fractional velocity change.

BALANCING

83-1055
Adjustable Balance Weight for Rotating Shaft

D.J. Wiebe
Dept. of Air Force, Washington, DC, U.S. Patent Appl. No. 6-393 267, 30 pp (June 29, 1982)

Key Words: Balancing techniques, Shafts, Rotors

A balance weight mechanism is attached to a tubular engine shaft for correcting unbalance in the engine. The tubular shaft includes a stiffener plate mounted therein transversely to the rotational axis of the shaft. The balance weight mechanism includes a balance weight arm and a fastener for releasably fastening an end of the arm to a generally central location on the stiffener plate.

MONITORING

83-1056
Detect Incipient Failure by Monitoring Acoustic Emissions

P. Baur
Power, 126 (12), pp 69-73 (Dec 1982) 7 figs, 14 refs

Key Words: Acoustic emission, Monitoring techniques

Steps for optimizing the selection and installation of AE monitoring equipment are described.

83-1057
Vibration Monitoring of Bearings at Low Speeds

J.D. Smith
Univ. Engrg. Dept., Trumpington St., Cambridge, CB2 1PZ, UK, Tribology Intl., 15 (3), pp 139-144 (June 1982) 8 figs, 3 refs

Key Words: Monitoring techniques, Bearings

Some experimental observations and results are given comparing acceleration, shock pulse transducer, acoustic emission and jerk measurements from slightly damaged bearings at medium to low speeds.

83-1058
Avoiding Catastrophic Fatigue Failures

J.M. Steele and T.C.T. Lam
Stress Technology, Inc., Rochester, NY, Mach. Des., 55 (1), pp 101-105 (Jan 6, 1983) 4 figs

Key Words: Monitoring techniques, Fatigue life

This article explains how to apply fracture mechanics concepts to forecast material behavior during the crack propagation stage of the fatigue process.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

(Also see No. 931)

83-1059

The Continuous Vibration, When It is the Direct Moving of Core

I.S. Davydov.

Kabardino-Balkarskii gosudarstvennii Universitet, USSR, Vibrotechnika, 1 (39), pp 15-19 (1981) 1 fig, 3 refs

(In Russian)

Key Words: Core-containing structures, Random response

A differential equation for the determination of continuous vibration of a core, caused by periodic change of velocity in a random media, is derived. The equation is used to determine combination resonances.

83-1060

On the Problem of Autoparametric Resonances

L. Vorotyntsev

Institut mechaniki mashin, AN GSSR, Vibrotechnika, 1 (39), pp 35-48 (1981) 3 figs, 20 refs

(In Russian)

Key Words: Autoparametric response, Resonant response

Some aspects of the Mandelstam theory are discussed. It is shown that the problem of autoparametric resonances may be formulated as that of formation of dynamical instability regions for forced oscillations regimes and behavior of the systems inside the instability regions. As examples of the investigation and analogue simulation of differential equations systems with nonlinear damping and piece-wise linear type characteristic of restoring force are considered.

83-1061

An Analysis of an Unconditionally Stable Explicit Method

R. Mullen and T. Belytschko

Dept. of Civil Engrg., Case Inst. of Tech., Case Western Reserve Univ., Cleveland, OH 44106, Computers Struc., 16 (6), pp 691-696 (1983) 7 figs, 2 tables, 10 refs

Key Words: Dynamic structural analysis

Recently, several semi-implicit methods have been proposed for the time integration of the structural dynamics equations which are unconditionally stable yet explicit in their algorithmic structure. While these methods seem to violate the basic premise of the Courant requirement that the speed of information flow in the discrete model must not exceed that in the continuous problem, it is shown here that this is not the case.

83-1062

Substructure Analysis of Vibrating Systems

R. Greif and L. Wu

Dept. of Mech. Engrg., Tufts Univ., Medford, MA 02155, Shock Vib. Dig., 15 (1), pp 17-24 (Jan 1982) 75 refs

Key Words: Substructuring methods, Vibrating structures, Component mode synthesis, Truncation, Transfer matrix method, Condensation method, Reviews

This article summarizes work of the last three years on substructure analysis of vibrating systems. Among the topics are component mode synthesis including truncation procedures, transfer matrix methods, and condensation techniques. The discussion includes applications to a variety of engineering problems as well as nonlinear and nonconservative systems.

83-1063

Impulsive Responses of a Discrete Mechanical System and Their Utilization in Calculating Response to Non-periodic Excitation

J. Brynich

Central Res. and Testing Inst., SKODA plzen, Czechoslovakia, Strojnícky Časopis, 33 (6), pp 701-728 (1982) 18 figs, 7 refs

(In Czech)

Key Words: Lumped parameter method, Impulse response, Damped systems, Undamped structures

The paper deals with methodology of calculation and with calculation formulae applicable to the needs of a technical

practice in solving nonperiodic response of a linear mechanical system with multiple degrees of freedom. The impulsive responses of both undamped and damped systems are designed in the form of time series which are further utilized for the calculation of time series representing the waveform of generalized coordinates of the system. Given are graphically represented results of calculation of the response of the system with two degrees of freedom to nonperiodic excitation with a continuous waveform.

83-1064

The Non-Conservative Dynamic Systems

O. Danek
Institute of Thermomechanics, Czechoslovak Academy of Sciences, Prague, Czechoslovakia, Strojnický Časopis, 33 (6), pp 667-680 (1982) 5 refs
(In Czech)

Key Words: Dynamic structural analysis, Nonconservative forces

A theory of discrete non-conservative dynamic system with real matrices K, B, M of order m was previously introduced. This paper completes and generalizes the solution for a system of the Jordan-type.

83-1065

On the Analysis of Hopf Bifurcations

K. Huseyin and A.S. Atadan
Dept. of Systems Design, Univ. of Waterloo, Waterloo, Ontario, Canada, Intl. J. Engrg. Sci., 21 (3), pp 247-262 (1983) 4 figs, 26 refs

Key Words: Bifurcation theory, Harmonic analysis

The oscillatory instability and the family of limit cycles associated with a general autonomous dynamical system described by n nonlinear first order differential equations and an independently assignable scalar parameter are examined via an intrinsic method of harmonic analysis. The method is essentially a variation of the classical method of harmonic balancing, and is designed to eliminate the drawbacks and shortcomings associated with the latter. The new approach yields consistent approximations for the nonlinear dynamical bifurcation problem under consideration through a systematic perturbation procedure.

83-1066

A General Dynamic Synthesis for Structures with Discrete Substructures

L. Meirovitch and A.L. Hale
Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Sound Vib., 85 (4), pp 445-457 (Dec 22, 1982) 3 figs, 1 table, 20 refs

Key Words: Dynamic synthesis, Substructuring methods

This paper presents a substructure synthesis method for the dynamic simulation of complex structures, where the structures consist of an assemblage of discrete substructures. An analogy between distributed and discrete structures is extensively invoked. To stimulate the motion of discrete substructures, the concept of admissible vectors is introduced, where admissible vectors represent the discrete counterpart of admissible functions for distributed substructures. The individual substructures are forced to act as a whole structure by imposing certain geometric compatibility on internal boundaries shared by any two substructures. A numerical example illustrating the method is presented.

83-1067

A New Simultaneous Iteration Algorithm for Evaluation of Eigenproblems in Large Structures

Guoguang Liu and Junjie Li
Acta Aeron. et Astron. Sinica, 3 (1), pp 20-27 (1982)
CSTA No. 629.1-82.03

Key Words: Eigenvalue problems, Iteration

A new improved algorithm of simultaneous iteration is presented for evaluation of generalized eigenproblems in dynamic analysis of large structures. The convergence of this algorithm is proved by the concepts of E_K subspace and eigendirection and some details of how to perform this algorithm in computer are discussed.

83-1068

Some Comments on Wave Motions Described by Non-Homogeneous Quasilinear First Order Hyperbolic Systems

D. Fusco
Istuto di Matematica dell'Universita, Via C. Battisti

90, 98100 Messina, Italy, Meccanica, 17 (3), pp 128-137 (Sept 1982) 31 refs

Key Words: Wave propagation

In this paper a quasilinear first order hyperbolic system of partial differential equations involving a source term is considered. Thus in the usual context of the n-dimensional nonlinear wave propagation theory it is shown that the source term may produce attenuation effects against the typical nonlinear steepening of the waves.

83-1069

The Calculation of Non-Linear Eigenvalues in Dynamic Substructure Methods

Zhong Gen Hu, Wei June Yun, and Gen Bao Duan
Ship Engrg., 2, pp 13-20 (1982)
CSTA No. 623.8-82.16

Key Words: Eigenvalue problems, Substructuring methods

This paper describes the nonlinear eigenvalue problem existing commonly in some main dynamic substructure methods, and puts emphasis on discussing the principle and steps solving such eigenvalues. The authors set up the bisection method by revising the well-known Sturm sequence, and thus resolve the problem.

MODELING TECHNIQUES

83-1070

A Novel Method of Model Reduction with Adjustable Parameters

Zu Shu Li
Acta Automatic Sinica, 8 (2), pp 81-92 (1982)
CSTA No. 629.8-82.13

Key Words: Mathematical models

A new method with adjustable parameters for the reduction of high order linear time invariant dynamic system is presented. The method emphasizes the quasi-equivalent relation between the reduced order model and the prototype from the dynamic characteristics view of the systems. The desirable values of the adjustable parameters are selected closely to approximate the dominant frequency response data of the prototype system.

NUMERICAL METHODS

83-1071

Dynamic Analysis of Plane Mechanisms with Lower Pairs in Basic Coordinates

M.A. Serna, R. Avilés, and J.G. de Jalón
Cátedra de Mecánica, Escuela Superior de Ingenieros Industriales di Bilbao, Spain, Mech. Mach. Theory, 17 (6), pp 397-403 (1982) 6 figs, 2 tables, 21 refs

Key Words: Numerical analysis, Mechanisms

The numerical solution to the dynamic problem of planar mechanisms with lower pairs is presented. This method is based on the basic coordinates and link constraints.

83-1072

Numerical Operational Methods for Time-Dependent Linear Problems

G.V. Narayanan and D.E. Beskos
Southwest Res. Inst., San Antonio, TX, Intl. J. Numer. Methods Engrg., 18 (12), pp 1829-1854 (Dec 1982) 12 figs, 56 refs

Key Words: Numerical analysis, Time-dependent parameters, Laplace transformation

A general and systematic discussion on the use of the operational method of Laplace transform for numerically solving complex time-dependent linear problems is presented. Application of Laplace transform with respect to time on the governing differential equations as well as the boundary and initial conditions of the problem reduces it to one independent of time, which is solved in the transform domain by any convenient numerical technique, such as the finite element method, the finite difference method or the boundary integral equation method. The time domain solution is obtained by a numerical inversion of the transformed solution.

83-1073

A Numerical Solution for Open Resonators with Waveguides

Ming Yu, et al

Acta Electronica Sinica, 10 (1), pp 21-29 (1982)
CSTA No. 621.381-82.02

Key Words: Resonators, Numerical analysis

A numerical solution for open resonators with slow varying section waveguides is presented. By using this method, when the profile of the longitudinal section of an open resonator is given, the field distributions, the resonance frequencies and the radiational Q values may be calculated.

PARAMETER IDENTIFICATION

83-1074
Estimation of Parameters in a Linear Dynamic System with Missing Observations
D.S. Stoffer
Ph.D. Thesis, Univ. of California, Davis, 152 pp (1982)
DA8227893

Key Words: Parameter identification technique

A solution to some of the problems of estimation and prediction in a linear dynamic system when observations are missing is proposed. For an underlying state-space model, the EM algorithm is used in conjunction with modified Kalman smoothed estimates to derive a simple recursive procedure for estimating parameters by maximum likelihood. Under the assumption that the parameters are time invariant, the EM algorithm is derived analytically.

83-1075
Identification and Modeling of Nonlinear Systems
S.F. Masri, H. Sassi, and T.K. Caughey
Civil Engrg. Dept., School of Engrg., Univ. of Southern California, Los Angeles, CA 90007, Nucl. Engrg. Des., 72 (2), pp 235-270 (Sept 11, 1982) 33 figs, 9 refs

Key Words: System identification techniques, Mathematical models, Nuclear reactors

A nonparametric identification technique is presented for use with discrete multidegree of freedom nonlinear dynamic systems of the type encountered in nuclear reactor technology. The method requires information regarding the system response and estimates of its pertinent mode shapes to determine, by means of regression techniques involving the use of two-dimensional orthogonal functions, an approximate expression for the system generalized restoring forces in terms of the corresponding generalized system state variables. For the special class of nonlinear systems that have chain-like characteristics, drastic simplifications in the procedure are realized, and the identiication task can be easily and accurately accomplished without using any information regarding estimated mode shapes.

83-1076
A Dynamic Identification Method for Complex Structures
L. Barthe-batsalle
Office National d'Etudes et de Recherches Aerospatiales, Paris, France, Rept. No. ONERA-NT-1982-3, ISSN-0078-3781, 44 pp (1982)
N82-31726
(In French)

Key Words: System identification techniques, Complex structures, Harmonic response, Finite element technique

A global identification method for complex structures was developed to improve the finite element computation model for the study of harmonic vibrations based on measured natural modes. Modes are introduced as displacements imposed on a part of the structure in a static problem involving rigidity and mass operators. The method consists of seeking the unknown parameters which minimize the Euclidian norm of the reaction forces corresponding to the prescribed measured displacements. When numerous measured points are spread on the structure, it is possible to localize the modeling errors.

OPTIMIZATION TECHNIQUES
(See No. 934)

DESIGN TECHNIQUES
(See No. 1017)

COMPUTER PROGRAMS

83-1077
Research Report: User's Manual for Computer Program AT81Y005. PLANETSYS, a Computer Program for the Steady State and Transient Thermal Analysis of a Planetary Power Transmission System

G.B. Hadden, R.J. Kleckner, M.A. Ragen, G.J. Dyba, and L. Sheynin
SKF Technology Services, King of Prussia, PA, Rept. No. SKF-AT81D044, NASA-CR-165366, 142 pp (May 1981)
N82-31970

Key Words: Computer programs, Power transmission systems, Friction excitation, Periodic response

The material presented is structured to guide the user in the practical and correct implementation of PLANETSYS which is capable of simulating the thermomechanical performance of a multistage planetary power transmission. In this version of PLANETSYS, the user can select either SKF or NASA models in calculating lubricant film thickness and traction forces.

83-1078

AESOP: A Computer-Aided Design Program for Linear Multivariable Control Systems

B. Lehtinen and L.C. Geyser
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. E-1246, NASA-TM-82871, 7 pp (1982) (Pres. at the AM. Control Conf., Arlington, VA, June 14-16, 1982)
N82-30992

Key Words: Computer programs, Control equipment

An interactive computer program (AESOP) which solves quadratic optimal control is discussed. The program can also be used to perform system analysis calculations such as transient and frequency responses, controllability, observability, etc., in support of the control and filter design computations.

83-1079

A Doublet Lattice Method for the Determination of Rotor Induced Empennage Vibration Airloads. Analysis Description and Program Documentation

S.T. Gangwani
United Technologies Res. Ctr., East Hartford, CT, Rept. No. UTRC81-7, NASA-CR-165893, 68 pp (June 1982)
N82-31295

Key Words: Computer programs, Helicopters, Propeller blades, Aerodynamic loads, Vibration response

An efficient state-of-the-art method was developed to determine the unsteady vibratory airloads produced by the interaction of the main rotor wake with a helicopter empennage. This method was incorporated into a computer program, Rotor Induced Empennage Vibration Analysis (RIEVA).

83-1080

User's Manual for the Coupled Rotor/Airframe Vibration Analysis Graphic Package

R.E. Studwell
Sikorsky Aircraft Div., United Technologies Corp., Stratford, CT. Rept. No. NASA-CR-165897, 27 pp (June 1982)
N82-31299

Key Words: Computer programs, Helicopters, Vibration analysis, Graphic methods

User instructions for a graphics package for coupled rotor/airframe vibration analysis are presented. Responses to plot package messages which the user must make to activate plot package operations and options are described.

83-1081

A Prescribed Wake Rotor Inflow and Flow Field Prediction Analysis, User's Manual and Technical Approach

T.A. Egolf and A.J. Landgrebe
United Technologies Res. Ctr., East Hartford, CT, Rept. No. UTRC81-2, NASA-CR-165894, 79 pp (June 1982)
N82-31296

Key Words: Computer programs, Helicopters, Propeller blades

A user's manual is provided which includes the technical approach for the Prescribed Wake Rotor Inflow and Flow Field Prediction Analysis. The analysis is used to provide the rotor wake induced velocities at the rotor blades for use in blade airloads and response analyses and to provide induced velocities at arbitrary field points such as at a tail surface. This analysis calculates the distribution of rotor wake induced velocities based on a prescribed wake model.

83-1082

Aeroelastic Analysis for Helicopter Rotors with Blade Appended Pendulum Vibration Absorbers. Mathematical Derivations and Program User's Manual

R.L. Bielawa

United Technologies Res. Ctr., East Hartford, CT, Rept. No. UTRC81-45, NASA-CR-165896, 109 pp (June 1982)

N82-31298

Key Words: Computer programs, Rotors, Helicopters, Propeller blades, Vibration absorption equipment

Mathematical development is presented for the expanded capabilities of the G400 Rotor Aeroelastic Analysis. This expanded analysis, G400PA, simulates the dynamics of teetered rotors, blade pendulum vibration absorbers and the higher harmonic excitations resulting from prescribed vibratory hub motions and higher harmonic blade pitch control. Formulations are also presented for calculating the rotor impedance matrix appropriate to these higher harmonic blade excitations.

83-1083

Large Displacements and Stability Analysis of Nonlinear Propeller Structures

R.A. Aiello

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-82850, 18 pp (1982) (Pres. at the 10th Nastran User's Colloq., New Orleans, May 13-14, 1982)

N82-31707

Key Words: Computer programs, Propellers

The use of linear rigid formats in COSMIC NASTRAN without DMAP procedures for the analysis of nonlinear propeller structures is described. Approaches for updating geometry and applying follower forces for incremental loading are demonstrated. Comparisons are made with COSMIC NASTRAN rigid formats and other independent finite element programs.

83-1084

Evaluation, Improvement and Limits of a Computer Simulation Program for Exhaust Silencers for Four-Stroke Engines (Erprobung, Verbesserung und Grenzen eines Berechnungsverfahrens fur Abgasschalldampfer von Viertaktmotoren)

R. Glanz and B. Nowotny

St.-Peter-Haupstrasse 33c/3, A-8042 Graz, W. Germany, Automobiltech. Z., 84 (12), pp 627-630 (Dec 1982) 11 figs, 4 refs

(In German)

Key Words: Computer programs, Internal combustion engines, Silencers, Mufflers

This paper discusses the critical evaluation and subsequent improvement of a computer program for the design anu analysis of reflexive and resonator silencers for internal-combustion engines. The calculation method uses a predictor-corrector algorithm to solve the nonlinear partial differential equations describing the unsteady wave action. The silencer system is not considered in isolation, but in interaction with the engine during the exhaust phase. The calculation gives the variation with time of the thermodynamic properties and velocity of the gas at various positions throughout the whole exhaust system. Using acoustic theory, calculations of the sound level radiated from the tailpipe alone can be made.

83-1085

Computerized Mathematical Eigenvalue Models. 1970 - October, 1982 (Citations from the NTIS Data Base)

NTIS, Springfield, VA, 150 pp (Oct 1982)

PB83-851352

Key Words: Computer programs, Eigenvalue problems, Bibliographies

This bibliography contains 133 citations concerning various computer programs and techniques used to solve mathematical problems too large and/or complex for manual manipulation. Most of the citations are slanted toward the solution of sophisticated matrices as they relate to the problems of structural design, stability, dynamics and loading. Computerized theoretical formulas and equations applicable to general areas of engineering are also presented.

GENERAL TOPICS

TUTORIALS AND REVIEWS

83-1086

Structures and Dynamics Division Research and Technology Plans, FY 1982

K.S. Bales

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-84509, 56 pp (June 1982)
N82-30566

Key Words: Finite element technique, Microprocessors (computers), Crashworthiness, Crash research (aircraft)

Computational devices to improve efficiency for structural calculations are assessed. The potential of large arrays of microprocessors operating in parallel for finite element analysis is defined, and the impact of specialized computer hardware on static, dynamic, thermal analysis in the optimization of structural analysis and design calculations is determined. General aviation aircraft crashworthiness and occupant survivability is also considered.

83-1087
Structural Engineering Research Centre: Annual Report 1980-81
Structural Engrg. Res. Centre, Madras, India, 52 pp (1981)
PB83-100966

Key Words: Framed structures, Reinforced concrete, Structural members, Facilities

This report enumerates the major research activities of the Centre during the year. Considerable progress was made in the nonlinear elastic/inelastic analysis of framed structures. A numerical model was developed to simulate the inelastic behavior of a reinforced concrete member.

CRITERIA, STANDARDS, AND AND SPECIFICATIONS

(See No. 1017)

BIBLIOGRAPHIES

83-1088
Mechanical Impedance. June, 1970 - October, 1982 (Citations from the NTIS Data Base)
NTIS, Springfield, VA, 124 pp (Oct 1982)
PB83-851766

Key Words: Mechanical impedance, Bibliographies

This bibliography contains 95 citations concerning the measurement, theory, and reduction methods of mechanical impedance. Assembled aerospace equipment, rotors, multiresonance systems, and machine tools are among the mechanical systems analyzed.

USEFUL APPLICATIONS

83-1089
Vibratory Compacting of Powder Metal and Refractory Material Parts. 1966 - October, 1982 (Citations from the Metals Abstracts Data Base)
NTIS, Springfield, VA, 78 pp (Oct 1982)
PB83-851097

Key Words: Compaction equipment, Vibratory techniques, Metals, Nuclear fuel elements, Bibliographies

This bibliography contains 123 citations concerning the techniques and equipment for the vibratory compaction of refractory materials and powder metals. Emphasis is placed on ultrasonic compaction, and the manufacture of power metallurgical parts as well as refractory metal carbides. The compaction of nuclear fuel elements using uranium oxide powders is included.

AUTHOR INDEX

TECHNICAL NOTES

A. Trochidis
Flanking Transmission in Buildings Using Energy Methods
Acustica, 52 (1), pp 36-39 (Dec 1982) 10 figs, 5 refs

J.M. Garrelick
The Probability of Exciting an Elastic Structure with a Given Resonant Amplification Factor
J. Acoust. Soc. Amer., 72 (6), p 2035 (Dec 1982) 1 ref

V.S. Holla, A.R. Manjunath, and J. Nagabhushanam
Helicopter Rotor Performance Evaluation Using Oscillatory Airfoil Data
J. Aircraft, 19 (12), pp 1102-1104 (Dec 1982) 1 fig, 7 refs

P. Verniere de Irassar, G.M. Ficcadenti, and P.A.A. Laura
Vibrations of Nonuniform Beams with One End Elastically Restrained Against Rotation
AIAA J., 21 (2), pp 312-314 (Feb 1983) 1 fig, 3 tables, 8 refs

K.R. Rajagopal and A.S. Gupta
Remarks on "A Class of Exact Solutions to the Equations of Motion of a Second Grade Fluid"
Intl. J. Engrg. Sci., 21 (1), pp 61-63 (1983) 1 ref

M.F. McCarthy
Wave Propagation in Linear Viscoelastic Composites Modelled as Interpenetrating Solid Continua
Intl. J. Engrg. Sci., 21 (1), pp 65-75 (1983) 8 refs

E. Zwicker and A. Scherer
Masking of Continuous Pure Tones by Rectangularly-Gated Broadband Noise (Zur Verdeckung von Dauertönen durch rechteckförmig moduliertes Breitbandrauschen)
Acustica, 52 (2), pp 115-117 (Jan 1983) 1 fig, 1 table, 6 refs (In German)

M. Bechly
Dependence of Suppression at 8 kHz on the Frequency-Ratio and the Sound-Pressure Level of the Two Maskers (Zur Abhängigkeit der „suppression" bei 8 kHz vom Frequenzverhältnis und den Schallpegeln der beiden Maskierer)
Acustica, 52 (2), pp 113-115 (Jan 1983) 3 figs, 9 refs (In German)

H. Davis
Noise from Time Varying Sources: Estimation of Component Variance
Appl. Acoust., 16 (2), pp 147-153 (Mar 1983) 2 tables, 7 refs

CALENDAR

JUNE 1983

6-10 Passenger Car Meeting [SAE] Dearborn, MI *(SAE Hqs.)*

20-22 Applied Mechanics, Bioengineering & Fluids Engineering Conference [ASME] Houston, TX *(ASME Hqs.)*

21-24 International Conference on Modern Vehicle Design Analysis [International Association for Vehicle Design] London, England *(Drs. M.M. Kamal and J.A. Wolf, Jr., Engineering Mechanics Dept., General Motors Research Labs., Warren, MI 48090 - (313) 575-2929)*

JULY 1983

11-13 13th Intersociety Conference on Environmental Systems [SAE] San Francisco, CA *(SAE Hqs.)*

AUGUST 1983

8-11 Computer Engineering Conference and Exhibit [ASME] Chicago, IL *(ASME Hqs.)*

8-11 West Coast International Meeting [SAE] Vancouver, B.C. *(SAE Hqs.)*

SEPTEMBER 1983

11-13 Petroleum Workshop and Conference [ASME] Tulsa, OK *(ASME Hqs.)*

11-14 Design Engineering Technical Conference [ASME] Dearborn, MI *(ASME Hqs.)*

12-15 International Off-Highway Meeting & Exposition [SAE] Milwaukee, WI *(SAE Hqs.)*

14-16 International Symposium on Structural Crashworthiness [University of Liverpool] Liverpool, UK *(Prof. Norman Jones, Dept. of Mech. Engrg., The Univ. of Liverpool, P.O. Box 147, Liverpool L69 3BX, England)*

25-29 Power Generation Conference [ASME] Indianapolis, IN *(ASME Hqs.)*

28-30 Rotating Machinery Vibration Symposium [Vibration Institute] Worcester, MA *(Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

OCTOBER 1983

17-19 Stapp Car Crash Conference [SAE] San Diego, CA *(SAE Hqs.)*

17-20 Lubrication Conference [ASME] Hartford, CT *(ASME Hqs.)*

18-20 54th Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, DC] Pasadena, CA *(Mr. Henry C. Pusey, Director, SVIC, Naval Research Lab., Code 5804, Washington, DC 20375)*

31-Nov 4 John C. Snowdon Vibration Control Seminar [Applied Research Lab., Pennsylvania State Univ.] University Park, PA *(Mary Ann Solic, 410 Keller Conference Center, University Park, PA 16802 - (814) 865-4591)*

NOVEMBER 1983

6-10 Truck Meeting and Exposition [SAE] Cleveland, OH *(SAE Hqs.)*

7-11 Acoustical Society of America, Fall Meeting [ASA] San Diego, CA *(ASA Hqs.)*

13-18 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Boston, MA *(ASME Hqs.)*

MARCH 1984

20-23 Balancing of Rotating Machinery Symposium [Vibration Institute] Philadelphia, Pennsylvania *(Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

APRIL 1984

9-12 Design Engineering Conference and Show [ASME] Chicago, IL *(ASME Hqs.)*

9-13 2nd International Conference on Recent Advances in Structural Dynamics [Institute of Sound and Vibration Research] Southampton, England *(Dr. Maurice Petyt, Institute of Sound and Vibration Research, The University of Southampton, S09 5NH, England - (0703) 559122, ext. 2297)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass Ave., N.W.
Washington, D.C.

AHS American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
Owles Hall, Buntingford, Herts.
SG9 9PL, England

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 5804
Washington, D.C. 20375

URSI-USNC: International Union of Radio Science - U.S. National Committee
c/o MIT Lincoln Lab.
Lexington, MA 02173

PUBLICATION POLICY

Unsolicited articles are accepted for publication in the Shock and Vibration Digest. Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .

The format and style for the list of References at the end of the article are as follows:

- each citation number as it appears in text (not in alphabetical order)
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- titles of articles within quotations, titles of books underlined
- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, number or issue, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Pletzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).

2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).

3. Jones, W.P., (Ed.), "Menual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Daval. (1962).

4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).

5. Lendahl, M., Unsteady Transonic Flow, Pergamon Press (1961).

6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnal," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).

7. Lane, F., "Supersonic Flow Past an Oscilleting Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

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